THURSDAY, JULY 25, 1878

BOTANY IN AMERICA

Synoptical Flora of North America. By Asa Gray, LL.D., Fisher Professor of Natural History (Botany) in Harvard University. Vol. ii. Part 1. (New York, 1878.)

Bibliographical Index to North American Botany, with a Chronological Arrangement of the Synonymy. By Sereno Watson. Part 1. Polypetalæ. (Washington, 1878.)

AS with the British nation, so with the American, the rapid extension of its territorial boundaries, and absorption of outlying regions abounding in new and interesting forms of life, has determined to a great extent the direction and progress of the natural history sciences which it cultivates.

The first requisite of the explorer who brings back with him collections illustrative of the new or little-known countries he has visited is to know what these are; and the emigrant and colonist who follows the explorer makes the further demand upon the naturalist of the means of ascertaining the names and relationships of the useful, ornamental, noxious, or otherwise remarkable plants of his new home.

Hence the more rapid strides of classificatory and descriptive botany in England and America than in any other countries, the multiplicity of botanical appendices to narratives of voyages, travels, surveys, and explorations; and those libraries of local and general floras which have contributed so largely to our knowledge of the vegetable world. In this respect, namely, the accession of new domains, America and England have no rival but Russia, and in her case the newly-acquired or explored territories have in many cases, from the scantiness of their floras, yielded comparatively little of botanical interest. France, indeed, during the last decade of the past and first of the present centuries, displayed remarkable activity in this direction, stimulated thereto by the genius and activity of Richard, De Candolle, St. Hilaire, and many other botanists, and by the accumulation of collections brought by her naval expeditions and geographical explorations; but latterly she has left the field to the Anglo-Saxon; and her publications relating to the botany of her later voyages are too often ambitious failures, *ouvrages de luxe*, abandoned and left incomplete after the first few parts have dazzled the scientific world by their size and beautifully executed plates; whilst of her latest and most splendid territorial acquisition, Algeria, we must go to the work of an Englishman (Munby) for even a catalogue of its botanical riches.

America, on the other hand has gone about her work of this kind in an eminently practical fashion. Most of her local floras, and they are very numerous, are exceedingly well done, and complete up to their date of publication, whilst the botanical collections made during her almost innumerable topographical, geological, boundary, and railroad surveys have been published with a completeness and accuracy that leave little to be desired; and these hence form most valuable contributions not only to systematic but to geographical botany.

Of the contributors to this branch of botanical literature in America none is entitled to take rank with Prof. Asa Gray, of Harvard, Massachusetts, whether in respect of the amount of labour undertaken, or the treatment of it; and there is certainly no living botanist whose work has better stood the test of time and subsequent scrutiny, or who has turned his materials to better account in dealing with problems of classification and geographical distribution.

One circumstance alone has stood in the way of the recognition of the merits of this class of work, which is the fragmentary character of most of it, and the fact that so much of it has appeared as appendices and supplements to ponderous volumes descriptive of territorial and other surveys, which have necessarily a limited circulation, and whose titles are unfamiliar to scientific inquirers.

It has long been felt that there was but one way of satisfactorily dealing with the mass of materials of this nature that had been accumulating in the United States for now thirty-five years, and this was the resumption by the surviving author of Torrey and Gray's "Flora of North America," which was begun in 1838, and of which the last part, embracing the Compositæ, was published in 1843. Happily the surviving author has not been allowed to lose sight of the fact, that to him alone would botanists look with confidence for its satisfactory completion, and he has consequently been in the habit of so working up the materials confided to him for publication from the numerous expeditions alluded to and from private sources, that these should be directly available for the final effort to complete the American flora.

In commencing this, two courses were open to Dr. Gray: to re-edit, with additions, the antiquated volumes already published and continue onwards, or to begin where the old work ended, and re-edit afterwards the previously published ones. Dr. Gray has chosen the latter course, and, we doubt not, wisely; it leaves the lighter task for the future. It also more quickly meets the necessary wants of botanists, for the first volumes are, to a very important extent, supplemented by Sereno Watson's "Bibliographical Index to North American Botany," which gives references to all the genera and species added to the American flora since 1843, as well to those published up to that time.

In various other respects, also, the model of the old flora of North America has been advantageously departed from; a new title, of "Synoptical Flora of North America," has been adopted; the pages are larger and the type smaller (though still beautifully clear); synoptical tables of the genera are introduced under each order; and the synonomy and references have been greatly reduced, these being supplied by Watson's above-mentioned bibliography.

The work embraces all the regions of America belonging to the United States and Great Britain, thus excluding Greenland, the flora of which is more European than American. The part now published contains 400 pages, and embraces thirty-two Gamopetalous orders (from Goodeniaceæ to the end of that division of Dicotyledons) according to the sequence of Bentham and Hooker's "Genera Plantarum," the limitation of orders in which work is closely followed. The orders include 321 genera and

1,663 species, according to a statement in the Bulletin of the Torrey Botanical Club of New York (May, 1878), which contains a justly appreciative notice of the work. The preface states that the whole will be completed in two volumes of 1,200 pages each, which, if the forthcoming parts contain as many species as that now before us, would imply that the known phænogamic floras of the area embraced consists of about 10,000 species, a rather larger number than is included in Nyman's "Sylloge Floræ Europeæ," published in 1855, which contains 9,738.

If this latter number represents even approximately the extent of the European Flora, it shows that Europe contains, in proportion to its area and latitude, more plants than temperate North America: for its area (3,600,000 square miles) but little exceeds that of North America, exclusive of the vast British possessions, whilst the United States extends almost into the tropics and contains many subtropical plants. This superior botanical richness of Europe is no doubt due to the great diversity of the floras of its three southern peninsulas, Spain, Italy, and Greece, and to the number of species in its central mountains; as also to the prevalence of annuals, in which Europe far outnumbers any other continent. On the other hand, Dr. Gray's views of the limitation of species are no doubt large, compared with that adopted by Dr. Nyman.

Before concluding this notice of Dr. Gray's work, we may notice the identification of the North American *Solanum Fendleri*, Gray, with the potato (*S. tuberosum*) as var. *boreale*, thus giving this esculent a range from Chili and Buenos Ayres to the United States.

Mr. Watson's "Bibliographical Index to North American Botany" is not a mere compilation, as its title would make it appear, but a first-rate contribution to botanical science; the authorities cited being in all possible cases verified by a reference to the works themselves, and often by a critical study of the specimens by a botanist of scrupulous exactness, who is also well acquainted with the North American Flora, as collaborator with Asa Gray in the herbarium at Harvard. The first part, now published, includes the Polypetalous Dicotyledons, thus covering the ground of the first volume of Torrey and Gray's "Flora of North America," published in 1838-40. Next to Gray's Synoptical Flora this is the greatest boon to systematists that has appeared in North America for many a year, and it is further a necessary adjunct to the Synoptical Flora, containing as it does a mass of citations of descriptions and plates, of which that work is thus relieved.

It is further very interesting as showing the additions made to North American Botany since the publication of Torrey and Gray's above-mentioned first volume. Taking ten of the most considerable American orders of Polypetalæ, we find that in 1840 these included 262 genera and 1,267 species, to which have been added in the thirty-seven years that have elapsed since that period, only 12 genera, but 756 species. In so far as this affords the means of forming a rough estimate, it shows that the discoveries during the period in question, and which are almost confined to the southern and western States, have added about one-third to the previously known North American flora. These additions affect the different orders very variously, as might be expected; thus, whilst the increments to some, as *Ranunculaceæ* (20) and *Caryophylleæ* (16) are small, and of others moderate, as *Onagrariæ* (24), *Rosaceæ* (28), and *Saxifrageæ* (10), those of *Umbelliferæ* (45) are large; the orders *Cruciferæ* (95) and *Onagrariæ* (47) have been nearly doubled, *Leguminosæ* (360) more than doubled; and to *Cacti*, of which but nine species were known at the first period, 111 have since been added!

In two comparatively unimportant matters of convenience the author has departed from usage, and, we think, without good cause; the genera and species are not numbered either in Gray's or Watson's work, on what grounds we cannot imagine. To have to run up the numbers of the large genera (as Astragalus), for the purpose of comparing or contrasting the items of the American flora with those of others, involves a grievous loss of time to the botanist, whilst for the arrangement of herbaria, and ready reference in it to these standard books, the numbering would have been very useful. The other departure is the alphabetical arrangement of the genera under the orders in the "Bibliography," which, in the case of genera absorbed, necessitates a reference to the index.

If a few copies, with the matter printed on one side of the page, could have been obtained by botanists, it would have been a great boon. In such a case the pages of the "Bibliography" might have been intercalated with those of Gray's "Synoptical Flora;" and each species, with its references, might have been cut out and attached to the herbarium specimens of the species.

It remains to wish these able and industrious authors successfully through the works they have so well begun.

J. D. HOOKER

THE HYDROIDS OF THE GULF STREAM

Report on the Hydroida collected during the Exploration of the Gulf Stream by L. F. de Pourtalès. By G. J. Allman, M.D., F.R.S., President of the Linnean Society. (Cambridge, U.S., 1877.)

THIS report forms No. 2, vol. ii. of the quarto memoirs of the Museum of Comparative Zoology at Harvard College, and has been published by permission of the Superintendent of the United States Coast Survey, and is illustrated by thirty-four plates. It forms one of the most important contributions to the natural history of the hydroids that have appeared of late years, and it describes a very large number of most interesting and new forms. One of the sub-orders of the hydroida is well characterised by having the hydroids quite unprotected—not covered by any external protective receptacle. In this sub-order (Gymnoblastea) but nine species were found in Pourtalès' collection. Although they are all referable to known genera, yet all of them are new. The great bulk of the collection belonged, however, to another sub-order, in which the hydroids are provided with external protective receptacles (hydrotheca), and which is more or less familiar to us as containing the Campanularian and Sertularian forms. Of this sub-order (Calyptoblastea) some fifty-six species are described, and among the Sertularinæ no less than seven new genera are described, with forty-two new species out of a total of forty-three. Among the Campanularinæ two

new genera are described, with twelve new species out of a total of thirteen. In addition to these new species there were but seven others which, so far as their identification was possible, were already known as European forms. The collection had been preserved in spirits and was for the most part in excellent preservation. It would seem obvious that the region from which this collection had been obtained, and which includes an area between the Florida Reef on the north and west and Cuba the Salt Key and Bahama Banks on the south and east, is characterised by a very distinct hydroid fauna, and must form part of a special province in the geographical distribution of the Hydroida, though of course further researches may greatly extend the area of the new forms. The greatest depths at which any species had been dredged was 470 fathoms. The collection was rich in the plume-like hydroids (Plumulariadæ). In some genera of this beautiful family of hydroids the ultimate generative zooids which give origin to either the germ or the sperm cells (gonophores) are developed within a horny covering (gonangium), groups of which are often to be found inclosed in most curious basket-like receptacles (corbula). Such basket-like receptacles are well seen in Aglaophenia, and in a new species described as *A. bispinosa*, they attain a very large size and form most beautiful objects. In this genus the twigs of the cradle are much altered pinnæ which are pressed into a protective service. In one of Dr. Allman's new genera nearly allied to Aglaophenia (Cladocarpus) the groups of gonangia are not inclosed in corbulæ, but are borne on the sides or at the base of special protective branches which are not altered pinnæ but appendages to them. They certainly seem to act the part of corbulæ, and to form very effective organs of defence to the gonangia—though they do not present so effectual a covering as in Aglaophenia. In one magnificent species (*Cladocarpus paradisea*) the stem of which attains a height of fourteen inches, these phylactogonia, as Dr. Allman calls them, are in the form of pinnately-branched offshoots. In another species (*Cladocarpus dolichotheca*) the stem for nearly the whole of its course carries a longitudinal series of tubular receptacles which contain sarcode in which thread-cells are found. These nematophores, which are situated at short and equal intervals from one another, give to this part of the hydroid colony a very close resemblance to certain forms of graptolites. Elsewhere Dr. Allman has called attention to the close affinity that appears to exist between the so-called denticles of the graptolites and the nematophores in these Plumularian hydroids; and, as we know, that these bodies in the hydroids are not only filled with protoplasm, and that this is capable of developing pseudopodia after the manner of some rhizopods, this might seem to point to a relationship between the graptolites and the rhizopods through some ancestral form in which the affinities looked on the one side to the hydroids and on the other to the rhizopods, the graptolites having stopped short of the progress which the hydroids were enabled to make.

The beautiful plates illustrating this memoir have been executed by the faithful pencil of Mr. Hollick, though the details of structure have been drawn by the skilled and practised hand of the author. E. P. W.

OUR BOOK SHELF

Automatic Arithmetic: a New System for Multiplication and Division without Mental Labour and without the Use of Logarithms. By John Sawyer, Public Accountant. (London: George Bell and Sons, 1878.)

THIS is an ingenious work, and would have suited the "fantastical" Armado ("I am ill at reckoning; it fitteth the spirit of a tapster"). By the aid of 1759 figures only the user of it is able to multiply any two numbers each not exceeding 999,999,999, and also to divide one number by another, neither exceeding the same limits.

Its advantage over logarithms, in the cases to which it applies, is that the results are accurate instead of approximate.

The principle of construction is very simple: take ten pages; at the top of each write the nine digits in succession (for facility in working, the numbers are printed red and black alternately); cut each page into nine horizontal sections, and at the end of each strip write the same number (viz., for the fifth page the constant number will be 4), then on each strip will be printed

04 08 12 16 20 . . . 36

the printing being so arranged that each strip shall have the numbers of the previous strip printed one place further to the right. From this description it will, we think, be readily seen how to apply the tables to multiplication. To take a very simple example (any other example coming within the limits we have specified can be worked with almost equal facility), multiply 374 by 7.

Take the larger of the two numbers; turn back all the top row slips above 3, then all the second row slips above 7, then all the third row slips above 4, then carry the eye down the vertical column corresponding to the number, and we see (in this case in black figures)—

21
 49
  28

whence, adding, the result is seen to be 2618.

Each additional figure in the multiplier gives a result similarly obtained, and the answer is got by no mental operation more difficult than simple addition. A mere child who can add numbers together can thus perform mechanically (or automatically) difficult exercises in multiplication. Division is similarly reduced to subtraction. Whether much saving of time and labour is effected is a question we leave to practical men. We showed the work to a class of boys, and they were much interested in watching the process, the principle of which was readily understood by them.

Numbers can thus be easily raised to powers, but the method does not serve for the extraction of roots. We need hardly state that the tables are protected by letters patent.

A Handbook of the Plants of Tasmania. By the Rev. W. W. Spicer, M.A., &c. (Hobart Town: J. Walch and Sons, 1878.)

THIS little book of 160 pages contains a great deal more valuable matter than would at first sight appear. The author justifies the production of his book from the fact that previously existing works treating of Tasmanian plants are though "works of extraordinary merit, costly and ponderous," in proof of which he points to the labours of Hooker, Mueller, and Bentham, all of whose works are undeniably of very great value, but if for no other reason than their bulk, quite unfitted to be the companion of a botanical ramble. The book before us is intended for this purpose, being convenient in size, and as the author tells us in his preface, "moderate in cost." With regard to the plan of the book, the author's own description will make it more clear than any words of our own. He says,

"the descriptions are arranged on the branched or binary system, first established by the French naturalist Lamarc. Under this system, a series of salient characteristics is laid before the reader in pairs, the numbers of each pair being as nearly as possible opposed in their terms, and each giving rise to a new pair in like manner contradictory. The choice of these contradictions being left to the reader, he selects the number which applies most nearly to his specimen, and then passes on to the next pair. It is evident that, sooner or later, the several series of characters must be exhausted, and the name of the plant arrived at." The method of using this system is so fully explained further on, that, by following the author, no one can possibly fail to understand it and to be able to identify any plant by its aid. It is, in short, an exhaustive system by which the plant we may be examining is, so to speak, run into a corner and so fixed in its proper place. Thus we have a pocket flora of the colony in which not only the scientific, but, in most cases, also the common or colonial names are given. A short glossary of botanical terms, illustrated by figures, is placed at the beginning of the book, but this includes only such words as it was found absolutely necessary to use in the book. The aim of the author in assisting to popularise a knowledge of Tasmanian plants amongst the colonists will, no doubt, be furthered by the appearance of this little volume. A more careful revision of the proof-sheets, however, would have repaid for the extra time so spent. We think, also, that the adoption of some recognised system of spelling the natural orders would have had its advantages. Thus, we find Ranunculeæ instead of Ranunculaceæ, Lobeleæ instead of Lobeliaceæ, while, on the other hand, Papaveraceæ, Scrophulariaceæ, Lauraceæ, and others, occur as we have written them.

The coloured frontispiece of the Waratah (*Telopea truncata*) is, to say the least, a poor attempt at plant-figuring, both the drawing and colouring being equally bad.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.*]

The Natural History Collections

I SEE by *Galignani*, the only newspaper that reaches this high elevation, that a bill has just been introduced into Parliament by Mr. Walpole, and read a second time, to enable the Trustees of the British Museum to move the natural history collections into the new building at South Kensington. Not having before me a copy of the Bill, I cannot say whether it contains any clauses to alter the present mode of government of the natural history collections, but if such be not the case, and it is proposed to leave the new institution at South Kensington under the domination of the Trustees of the British Museum, I can assure Mr. Walpole and his friends that they will cause bitter disappointment to the naturalists of the country by such a course of action. We have always looked forward to the epoch of the removal of the national collections of natural history to the new site as the only opportunity ever likely to arise of making a reform in their government. That a Board of Trustees consisting of the principal Officers of State and great nobles of this country could be abolished was, of course, impossible, but it was hoped that the great men of Bloomsbury would not care to extend their authority to South Kensington. It will not be forgotten that the Royal Commissioners on Science, who went into this question in full detail, came exactly to this conclusion, and recommended that the new museum, when constituted, should be placed under a director immediately responsible to one of the ministers. And there can be no doubt that this should be done, and that the Act which authorises the removal of the collections should give them their new constitution. Our two best scientific institutions in this country—Greenwich Observatory and Kew Gardens—are governed after this fashion, and could never have attained their present standard of excellence under the rule of fifty irresponsible trustees.

Let me briefly point out the evils of the present system of government of the British Museum as regards the natural history collections. The "principal librarian" is secretary to the trustees and sole executive officer. His policy is, naturally enough, to get all he can for his books, and to keep the expenditure on the natural history branches as low as possible. One glance at the estimates annually proposed for the various departments in the British Museum will be sufficient to show how well this policy is carried out. It may be that the trustees will ask to appoint a new secretary and executive officer for the new building at South Kensington, and that the estimates for the two institutions will be kept separate. I trust that such may be the case, as it will partially mitigate the evils of which I complain. But I much fear that the principal librarian will resist giving up any part of his present authority, and that the tendency to starve the natural history and pamper the library will remain as heretofore. I earnestly hope, therefore, that Mr. Walpole's bill will not pass into law unless it contain clauses to ensure a cessation of the disadvantages of the present system of government. It would be better far that it should not pass at all this session. Even the fabric of the new building will not be complete until next spring, and there is much to be done in the way of internal arrangements and fittings before the time comes to remove the collections. Why, therefore, should a bill of this importance be introduced and hurried through Parliament at the fag-end of the present session? It must be naturally supposed that the only object is to elude criticism and to keep the rights and privileges of the fifty trustees as far as possible inviolate. A NATURALIST

Hotel de la Furca, Canton Uri, Switzerland,
July 15

The Genesis of Cyclones

IT is to be gathered from Mr. Barham's communication on cyclones and anti-cyclones in NATURE, vol. xviii. p. 249, that he is probably unacquainted with either Prof. Dove's partial explanation of the effect of the earth's rotation on the winds, published nearly fifty years ago, or Prof. Ferrel's more recent and comprehensive memoirs on the same subject; not to speak of Mohn and Guldberg's elaborate discussion of the mechanics of cyclonic and anticyclonic movements in their "Études sur les Mouvements de l'Atmosphère," published within the last two years.

It is not, however, to point out the fact that Mr. Barham's idea has been anticipated by these, and indeed many other writers, that I address you; but rather to show that the theory of parallel currents, which Mr. Meldrum, among others, has appealed to to account for the formation of cyclonic storms, is, taken by itself, inadequate; since any circular movements generated, in the manner supposed, by opposite currents, cannot receive from them a greater velocity than the mean velocity of the generating currents; and the theory leaves unexplained the spiral indraught of the air, which both Mr. Meldrum's charts of cyclones in the South Indian Ocean, and those which I myself, the late Mr. Willson, and Mr. Eliot, have prepared of storms in the Bay of Bengal, show to be an invariable as it is probably an essential feature of all such storms.[1]

[1] Mr. Piddington is usually regarded as an upholder of the hypothesis of the truly circular or tangential movement of the winds in cyclones, and not without reason; since, although he admitted, as a possibility, an occasional spiral indraught, he regarded this as non-essential, and equally admitted that the winds may occasionally blow outwards from the tangential direction. In most of his charts he does not give all the observed wind directions, but in that accompanying his first memoir, on the storm of June 3-5, 1839, he has done so. If any one will refer to this chart, and, leaving out of consideration Mr. Piddington's hypothetical circles, will draw for himself the most probable course of the currents in accordance with the charted wind arrows, he will soon convince himself that this course is sharply spiral, and also that Mr. Piddington, probably influenced by the erroneous hypothesis of circular rotation, has misapprehended the several positions of the storm-centre, and has assigned to the storm a course quite at variance with its real course, and equally so with that of any storm since observed in the same sea. The case is an interesting one, because Prof. Dove, misled by Mr. Piddington's error, has made this storm the basis of an erroneous explanation of the origin of the storm in his well-known work on "The Law of Storms," which has been translated by Gen. Sabine. Of course, in pointing out an error, I would in no way seek to disparage the admirable and laborious work of Mr. Piddington, whose great merits I most willingly recognise.

The storms generated in the Bay of Bengal afford unusual facilities for studying the genesis of cyclones. We have observatories round three sides of the bay, and the sea is, at all times of the year, traversed in all directions by numerous steamers and sailing vessels, which have furnished abundant logs. Did parallel currents play any important part in the production of the vortices, they could not possibly escape our notice. But we find that the antecedent conditions of a cyclone are light, variable winds and calms, with a nearly uniform barometric pressure all round the coasts; and only to the south, in the neighbourhood of the equator, is there any considerable movement of the air, viz., from the west. Under these circumstances, the pressure falls over some part of the bay; most frequently in the middle, and especially to the west of the Andamans. This region of falling pressure is characterised by torrential rains, with, at first, but little wind; but after a day or two (sometimes several days) of this weather, a cyclonic circulation is set up, with a marked indraught in the neighbourhood of the cyclone cradle, and thus the storm is generated.

Having regard to these facts of observation, it appears to me that it is in the condensation of the heavy rain (constantly noted as "torrential" in ships' logs) over the cyclone cradle, that we have the real source of the energy of the incipient storm. The hypothesis of parallel currents fails to provide this energy; for it is obvious that the deviation of the winds under the influence of the earth's rotation can furnish no energy, and can produce only a moderate barometric depression, the amount of which depends on the velocity of the original winds, and can be calculated by Ferrel's law. When this is reached, the system of pressures and wind-movements will be in equilibrium. If (and this I am not prepared to deny) a cyclone is sometimes generated between parallel currents, it must be that the energy of the storm is supplied from some other source, and what this is, is, I think, clearly indicated by the case of the Bay of Bengal storms.

It was first noticed by Mr. Eliot as a general fact, that, during the formation of a cyclone in the Bay of Bengal, little or no rain falls on the coasts; while, as already remarked, it is exceedingly heavy over the place of the storm's origin. The vapour generated over the bay, which, under other circumstances would be carried away by the winds and condensed over the land, is then condensed over the bay itself. The quantity of latent heat thus set free is enormous; and as Reye has shown, is ample for the production of the most violent cyclone. It would be erroneous to say that the air is thereby warmed and expanded, because, of course, the very fact of its vapour being condensed proves that it must be cooling; but Welsh's and Glaisher's balloon observations show that in a cloud-laden atmosphere, the vertical decrement of temperature is slow, as compared with that in a clear atmosphere; and the same fact is further illustrated by the temperature of hill-stations in the wetter parts of the Himalaya as compared with that of the plains at their foot. At Darjiling, for instance, the temperature from June to August (the season of greatest cloudiness and heaviest rainfall) is only 17° or 18° below that of Goalpara. In February and March (the driest months) it is between 23° and 24°. The explanation of these facts is afforded by the different rates of cooling experienced by saturated and unsaturated air, respectively, in an ascending mass of air which is expanding under a constantly diminishing pressure. Saturated, *i.e.*, cloud-laden and rain-condensing air at 80° cools only 20° by the work done during its ascent from the plane of 30 inches pressure to that of 20 inches pressure, say through 10,000 feet; whereas unsaturated air cools about 54° in the same ascent, the exact amount varying slightly according to the quantity of vapour it contains. The latent heat set free in the condensation of cloud and rain is then entirely used up in the work of expanding the cloud-laden air under a constantly diminishing pressure, and economises more than half (indeed, in the case adduced, nearly two-thirds) of the sensible heat which furnishes the energy to unsaturated air. Hence, an ascensional current, however small, once set in action in a nearly saturated atmosphere, such as exists over the Bay of Bengal during the formation of a cyclone, carries warm air to a greater height than in the clearer and drier atmosphere around the coasts, relatively raising the mean temperature of the former air-column, and of course reducing its weight. This differential effect goes on increasing, and the ascending current becomes more rapid, until the indraught below attains the conditions of a cyclonic storm.

Now, in the case of parallel currents, there must be between them a region of calm; and, if this is over a sea of high temperature, it is conceivable that, as in the Bay of Bengal, local condensation may proceed for a sufficient time unchecked to lead up to the formation of a cyclone; but, in that case, the cyclone will be generated, not immediately, as supposed by Mr. Barham, by the energy of the pre-existing winds, but by their affording conditions in which another and far more potent source of energy comes into play.

H. F. BLANFORD

Dinard, France, July 10

The Tasimeter and Magnetisation

AFTER perusing an account, in a recent number of the *Scientific American*, of Edison's Tasimeter, it occurred to one of us to apply it to detect, and, if possible, to measure the elongation and shortening, which, as discovered by Joule, are produced in a bar of iron by magnetisation and demagnetisation. Accordingly to test whether the effect could be observed in this way, a rough specimen of the instrument was constructed, and with it some preliminary experiments made, an account of which may interest the readers of NATURE. A small cylinder, about half a centimetre in length and diameter, of the carbon used for Bunsen's cells, rested with its ends which were slightly rounded, in contact with two brass plates, one of which was fixed to a rigid upright attached to one end of the base of the instrument, while the other, resting with one end on the base, formed a spring, which in its normal position just touched the end of the carbon. A coil containing four layers of insulated wire, six turns to the layer, was wound round a tube ten centimetres long and eight millimetres in diameter, and fixed with its axis in line with that of the carbon cylinder. A piece of iron wire was then placed in the axis of the tube with one end resting against the spring, and the other in contact with the end of a screw working in a nut fixed to a rigid upright at the end of the base remote from the carbon. By means of this screw the pressure of the iron bar on the spring, and consequently of the spring on the carbon, could be varied at pleasure.

A terminal of copper wire, was attached to each of the brass plates bearing on the carbon, and joined up so that the carbon, plates, and terminals formed one of the resistances of a Wheatstone's bridge, in connection with which a battery of one Daniell's cell and a very delicate Thomson's reflecting galvanometer were used. When the iron wire forming the core of the electro-magnet had been so adjusted that there was only a very slight pressure on the carbon, the resistances of the bridge were arranged to make the deflection of the galvanometer produced by the current from the battery nearly zero. The galvanometer and battery keys were then put down and the current allowed to flow through the bridge during the remainder of the experiment. The electro-magnet was then excited by the current from three of Thomson's Tray Daniells. This produced a deflection of the image on the galvanometer scale of about fifty divisions in the direction indicating a diminution of the carbon resistance, which must have been caused by change of contact produced by increased pressure on the spring. The length of the iron core of the electro-magnet had therefore been increased by magnetisation. When the magnetising force was removed the image immediately returned to its former position. As a verification that the diminution of resistance indicated by the bridge arrangement was caused by elongation of the iron core, the adjusting screw was turned forward through a very small distance, when the deflection was found to be in the same direction as before. When the screw was brought back the image on the scale returned towards its zero. Experiments with various strengths of current gave perfectly accordant results.

We hope by replacing the comparatively rough adjusting screw by a micrometer screw to be able to make some measurements of the exact amounts of elongation or shortening produced in a piece of soft iron or steel by given changes of magnetic intensity. It may be remarked that this method of measurement could be advantageously applied in cases where the amount of change of dimensions to be discovered or measured is very small, but the force which it could be arranged to produce abundant.

University of Glasgow, July 12

ANDREW GRAY
THOMAS GRAY

Physical Science for Artists

THE curious phenomenon described by Prof. Brücke and Mr. Norman Lockyer, under the name of "les rayons de crépuscule," though rare and uncommon in the island of Ceylon, is

well-known to the natives under the title "Buddha's rays." It has also, I believe, been noticed in Cashmere. The phenomenon, which is very striking indeed under favourable conditions, is confined to the mountain region in the central parts of the above-named island, and is never, as far as I am aware, seen in the low country. It was therefore with considerable interest that I learnt that it is well known to the French, and had been seen by Mr. Lockyer at sea. In May, 1876, in a paper on "Remarkable Atmospheric Phenomena in Ceylon," read before the Physical Society and published in the *Proceedings*, I offered an explanation of this phenomenon, in accordance with the conditions under which it appeared. As this explanation is very brief, may I ask your permission to reproduce it *verbatim?*

"Not unfrequently in the mountain districts broad beams apparently of bluish light may be seen extending from the zenith downwards, converging and narrowing as they approach the horizon. This ray-like appearance is very similar to that seen before sunrise; only the point from which the rays proceed is *opposite* the sun: the rays themselves are very broad and blue in colour; and the spaces between them have the ordinary illumination of the rest of the sky. If we suppose in this instance that the lower strata of air are colder than the upper (a condition of the atmosphere which not unfrequently occurs in a tropical mountain district like that of Ceylon, where large currents of heated air sweeping up a valley cross another valley nearly at right angles and at a considerable elevation above it), the refraction spoken of in the case of Adam's Peak will be downwards instead of upwards. If, too, the observer be *below*, the veil of darkness will appear to him like a very elongated triangle, apex downwards, or broad ray, through which the blue sky beyond may be seen free from the palish illumination of the atmosphere, whilst on either side the ordinary illuminated sky will be seen. If now we suppose several isolated masses of cloud to partially obscure the sun, as was the case when I witnessed the phenomenon, we may have several corresponding inverted veils of darkness, like blue rays in the sky, all apparently converging towards the same point below the horizon. This apparent convergence of the beams is merely an effect of distance, as in the case of parallel rays of light from the rising or setting sun, the blue rays being practically parallel bands in the atmosphere devoid of illumination. It will be evident that conical-shaped clouds are not necessary to produce this effect. Isolated clouds of any massive form would be sufficient to throw the bands of shadow through the illuminated atmosphere, and refraction and perspective would do the rest. The above phenomenon is called by the Singhalese 'Buddha's rays;' and though, according to Sir Emerson Tennent, it is very varied in character and appears in different parts of the sky, yet I have only seen it when the sun was low at evening and when the rays converged to a point, apparently directly opposite the sun; and I do not think it possible for the phenomenon to be seen in any other position."

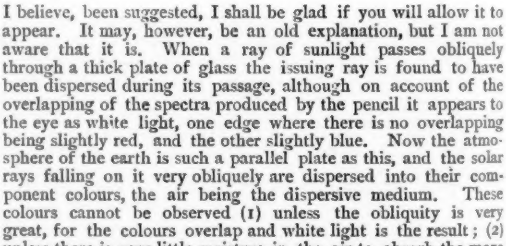
It will be seen that I thought it necessary to suppose a peculiar state of the atmosphere, in order that the shadows themselves might be sharply refracted downwards; indeed, I think, if the phenomenon can be produced under ordinary conditions, it would be much less rare in the island than it is. It may be mentioned that the sharpness and definition of the rays was most decided—far more so than the sunbeams and shadows are at sunrise or sunset—and that the position from which I observed the phenomenon was a ridge 4,500 feet high, overlooking a deep valley lying north and south, into which another valley running east and west opened at a high elevation, so that the warm air coming up the latter from the country below would overlie the cooler air of the first valley. I am not certain whether mountains a few miles to the west had any part in the production of the phenomenon, but the sun was certainly setting behind dense but isolated masses of cloud. With the above exception, it appears that my explanation is identical with that of Mr. Norman Lockyer and Prof. Brücke.

The reference in the above quotation to Adam's Peak is to the shadow which this isolated and cone-shaped mountain throws up into the sky at sunrise. The summit of this peak is 7,200 feet high, and overlooks the low country for fifty miles or more to the west. The shadow thrown by it at the moment of sunrise appears to lie horizontally over the land and sea for a distance of seventy or eighty miles. As the sun rises, the shadow rises and takes the form of a gigantic pyramid rising in the air and approaching the mountain, until at last it appears to fall over on the summit. The explanation which I offered of this was in principle identical with that of the mirage, the rays grazing the summit and sides of the mountain being refracted upwards, and thus leaving a portion of the atmosphere, similar in shape to the upper part of the Peak, unilluminated. This refraction is extremely likely to occur, as the difference in temperature between the air in the low country and on the top of the Peak is at least from 30° to 50° F. during the night and morning. The sudden vanishing of the shadow is, no doubt, due to the rays reaching the critical angle when the sun has risen to a certain height, and total internal reflection ceasing to take place. It may be mentioned that in both cases the shadows appear to be blue, but this, I imagine, is only the effect of contrast. This theory will, I believe, also explain the phenomenon of the spectre of the Brocken, which appears, I understand, under similar but less pronounced conditions.

The above appear to be very good instances of the illumination which the particles of air are capable of receiving, for it is evident that neither phenomenon would be visible if the atmosphere were perfectly pure.

Another phenomenon I shall be glad to refer to, as bearing on the subject of a perfectly clear sky at sunset. During the dry season on the West Coast of Ceylon, when the air is so free from moisture that even in houses close by the sea-shore the backs of books and sheets of paper curl up as if they had been placed before a fire, I have noticed, in looking westward over the sea immediately after sunset, that the sky has presented the appearance of an almost perfect spectrum extending from the horizon upwards for a very considerable distance towards the zenith (as far as I remember to within 20° of the zenith), a fiery red being lowest, succeeded by orange, yellow, green, and blue. With the exception of the red the colours were of the most transparent character possible; such as it seemed to me at the time it would be quite impossible to reproduce except with the prism or or diffraction lines.

The explanation which I would offer of this seems to bea directly on the question of the colour of the sky, and as it has not



I believe, been suggested, I shall be glad if you will allow it to appear. It may, however, be an old explanation, but I am not aware that it is. When a ray of sunlight passes obliquely through a thick plate of glass the issuing ray is found to have been dispersed during its passage, although on account of the overlapping of the spectra produced by the pencil it appears to the eye as white light, one edge where there is no overlapping being slightly red, and the other slightly blue. Now the atmosphere of the earth is such a parallel plate as this, and the solar rays falling on it very obliquely are dispersed into their component colours, the air being the dispersive medium. These colours cannot be observed (1) unless the obliquity is very great, for the colours overlap and white light is the result; (2) unless there is very little moisture in the air to absorb the more delicate colours and so prevent the dispersion effect being distinguished. In the case I refer to both these conditions were present in a remarkable degree. A reference to the figure will show at once the explanation offered for the spectral appearance of the sky. Let A A' be the surface of the earth, B B' the upper limit of the atmosphere, D D' the upper limit of the more refracting layers of the atmosphere, A the point of observation, A X the horizon.

A solar ray striking the atmosphere at P will be refracted and dispersed, the blue ray striking the earth at C, and the red at C'. When these rays reach the surface of a sea that is nearly calm they will be reflected in various directions according to the angle at which they strike the wave surfaces. Some will be reflected nearly vertically and will be lost in the clear sky, others will be reflected less vertically and will be subjected to the refracting influence of the lower strata of the air, the blue being refracted most and the red least. Thus the figure C F A may

represent the blue ray that suffers most refraction of all the blue rays, and C E A the red ray which suffers most refraction of all the red rays.

It thus appears that of blue and red rays reflected from the sea at the same angle, the former may reach the eye of the observer and the latter not, because, though the refraction is sufficient for the blue it is not so for the red ray, and it will be lost in the upper air. Consequently the blue rays will appear highest, and the red lowest, the other colours occupying intermediate positions according to their refrangibility. It is evident that any of these rays may be reflected too vertically from the sea, and so not be refracted to the earth again, but a considerable proportion will be thus refracted, and as has been said, more vertically inclined rays of the blue than of any other colour.

When we consider the effect of rays falling to the left of C, the phenomenon becomes more complicated. The same refraction, dispersion, and reflection take place, but the rays after reflection will mostly fall short of A, and strike the sea at various angles, producing a great variety of colour. It is not necessary for the effect that both the blue and the red from the same pencil of light should proceed to A, although this is shown for the sake of simplicity in the figure. It is sufficient if we know that blue rays, on account of their greater refrangibility, must of necessity be the highest, and the red, on account of their least refrangibility, the lowest.

If the above suggestion as to the dispersive power of the atmosphere be admitted, it is probable that the question of the colour and scintillation of stars will be directly affected by it.

Little Bromley, Manningtree, July 12 R. ABBAY

Zoological Geography—Didus and Didunculus

MR. SEARLES V. WOOD will, I trust, pardon me if I again take exception to the terms in which (*suprà*, p. 301) he still writes of *Didus* and *Didunculus*. These two birds do not belong to the same group of *Columbæ*. The fact that certain authors may have included them under the designation of "ground-doves" is no proof whatever of their relationship, any more than it is of the relationship of either to any other birds so called—for instance those of the Neotropical genus *Chamæpelia*. I have studied pretty carefully the osteology of many forms of *Columbæ* with especial reference to their affinities. *Pezophaps* and *Didus* are of course nearly allied, though even these are not congeners. *Didunculus* is at least as distinct from them as from all other *Columbæ* with the possible exception of *Otidiphaps*, which last I have not had an opportunity of examining. Furthermore, I may remark that if Mr. Wood will but look at what has been published of the habits of *Didunculus* he will find that it is as much an arboreal as a terrestrial bird, so that the name of "ground-dove" is as unhappily applied to it as is that of *Didunculus* or its ridiculous translation, "Dodlet."

July 22 ALFRED NEWTON

Autophyllogeny

THE following case of *Autophyllogeny*, observed in a leaf of *Papaya vulgaris* (the well-known papaw-tree) appears to me of sufficient interest to be recorded in the columns of your highly interesting journal.

The letter *a* designates the central part of the primary leaf, corresponding to the apex of the petiole on the upper side of the blade. It shows some small warty protuberances, and from amidst them rises a new petiole (*b*), about six centimetres long and one and a half millimetre thick. This new petiole bears an accessory leaf of somewhat pentagonal outline (*c*), slightly crumpled and partially concave towards the upper side (the one directed downwards in the figure), as if there had been some tendency of forming a leaf pitcher. A little onwards two boat-shaped appendices are observed (*d* and *e*), the midrib or petiole forming their keel. They are real leaf pitchers, though of a rather uncommon form. The small lateral diagram represents the shape of the transversal section through *f* and *g*. The two leaves are opposed to each other by their upper sides, which are of a dark green colour; the concave parts are their under sides, as is proved by their pale green colour, which is generally the case in the leaves of the papaw-tree. The end of the petiole bears a pointed leaf (*h*), slightly contracted, and with a pitcher-like contortion on one side. The figure is about three-fourths natural size.

The case belongs to those mentioned by Masters ("Vegetable Teratology," 355, 445) under the heads of Pleiophylly and Enation from foliar organs. His explanation is certainly correct, as there cannot be any doubt that the accessory petiole *b*, but for its development in another plane, is a true homologon of the ribs of the primary leaf, and the minute warts round its base may be regarded as small or checked beginnings in this same direction.

The described anomaly does not appear to be rare in *Papaya vulgaris*. I have observed several less-developed instances; the specimen here described was given to me by one of our students, Señor Ramon Documet. A. ERNST

Caracas, June 16

Microscopy—The Immersion Paraboloid

As I am responsible for exhibiting at the Conversazione of the Royal Society, May 1, the immersion paraboloid as being "designed by Dr. Edmunds," I should wish it to be known that, since that date, my attention has been directed to evidence establishing Mr. Wenham's priority to the invention.

Before exhibiting the paraboloid at the Royal Society, I had Dr. Edmunds' assurance that he felt justified in requesting me to describe it as designed by himself. JOHN MAYALL, Jun.

224, Regent Street, London, July 16

THE GENESIS OF LIMBS [1]

III.

I HAVE found much resemblance between the skeleton of the ventral and the dorsal fins in *Notidanus*, in *Chiloscyllium*, and in *Raia*; also between the anal and ventral fins in *Notidanus*. The ventral fins of elasmobranchs generally are so different from their pectoral fins, and so much more like the azygos fins than the pectorals are, that they serve well to bridge over the differences between the orders of fins. At the same time the value of the link is enhanced by the fact that in the very peculiar genera *Callorhynchus* and *Chimæra* the ventrals resemble the pectorals in a very remarkable and exceptional manner. But perhaps the most instructive ventral fin is that of *Polyodon*, the skeleton of which consists simply of a double series of simple parallel rays without any attachment to a pelvic cartilage which is altogether absent.

These conditions, then, appear to obliterate the distinctions which are at first apparent between the skeletons

[1] Continued from p. 311.

of the azygos and paired fins themselves. It remains to speak of the supporting structures of the paired fins, the pelvic cartilages or bones, and the shoulder-girdle. At first it appears that a formidable objection against the similar nature of the paired and azygos fins may be drawn from the existence in the former of these supporting structures (which serve in the pectoral region to fix the pectoral fins to the axial skeleton), while no such connection ordinarily exists with regard to the azygos fins.

We have seen, however, that in *Pristis* and *Pristiophorus* the dorsal fin becomes directly continuous with the axial skeleton by a mass of cartilage large enough to warrant comparison with the shoulder-girdle itself, while it is more or less firmly united with the axial skeleton in *Rhyncobates*, *Squatina*, *Acanthias*, *Spinax*, *Chimæra*, and *Callorhynchus*. It must be admitted, however, that the attachments of the dorsal fin to the axial skeleton is horizontal, direct, and continuous, while the structure supporting the pectoral fin (the shoulder-girdle) extends vertically, is arched in shape, and only abuts at one end against the axial skeleton, while ventrally it joins its fellow of the opposite side. These characters seem at first to tell against the similarity of nature of the dorsal and pectoral fins. But three things should be borne in mind—(1) the pectoral fin-support could not continuously adhere to the axial skeleton antero-posteriorily without impeding the lateral flexure of the body in swimming; (2) the pectoral fins join the body at too low a level for their support to extend in horizontally to the skeletal axis; (3) and did it so extend inwards in a straight line, even obliquely, it would intrude upon the visceral cavity. For these reasons the pectoral (and ventral fins also) must (if they are to rest on a solid support to facilitate their flapping motion) have a narrow connection with a sustaining structure, which structure must not be directly continuous, in a straight line, with the skeletal axis. Moreover, to obtain a firm basis, this limb-support, if it is attached obliquely upwards to the skeletal axis, must have some point to abut against ventrally also. Thus such support must assume the form of a limb-girdle.

I think, then, that there is sufficient evidence to warrant a belief that the skeletal structures of the paired fins of fishes (and therefore the limbs of higher vertebrates also) are the result of the centripetal growth and coalescence of a primitively distinct, parallel series of cartilaginous rays, developed in a pair of lateral fins similar to those developed, and more or less coalescing and centripetally extending in the median fins above and below.

But what about the limb-girdles themselves? Mr. James K. Thacher,[1] of New Haven, Connecticut, has thrown out the suggestion that the pelvic bones and cartilages of fishes (and therefore limb-girdles generally) are also due to the further extension inwards of such centripetal growth. I regard this as a most happy suggestion, and adopt it myself. The mystery of the limb-girdles is thus satisfactorily explicable; they are neither modified branchial arches, extra-branchials, nor ribs, but parts *sui generis*, due to the ingrowth of originally superficial structures—exoskeletal hardenings which have grown inwards and become endoskeletal.

It remains to consider the question of the development of the original digit-bearing limbs, *cheiropterygium*, from the primitive fin, or *archipterygium*.

Gegenbaur at first regarded the elasmobranch fin as derived from a limb formed like that of *Lepidosiren*, but he subsequently adopted that of *Ceratodus* as the archipterygium, in which view Huxley coincides. The former naturalist, however, considers the shark's fin and the cheiropterygium as formed by the all-but complete abortion of the rays on one side of the ceratodus limb-axis, with the simultaneous shortening and thickening of that axis into a metapterygium, while the rays of the other side of the axis coalesce to form the meso and propterygium. The latter anatomist (Huxley), on the contrary, regards the ceratodus-limb axis as forming by its progressive shortening (or drawing-in) the mesopterygium of the shark's pectoral, and the limb-axis of the cheiropterygium, the latter being perfected by the atrophy of the proximal lateral rays and the hypertrophy of the distal ones, the distal end of the axis becoming the middle digit of the hand. Of these two views the latter seems to me much to be preferred, but it demands the unity of the *centrale* carpal ossicle, which now seems most probably to have been primitively double, as it is so not only in *cryptobranchus*, but also in both limbs of three species of Siberian Urodeles.[1]

I believe, however, that the limb of *Ceratodus* is far from showing us a primitive form, but is, on the contrary, a very special and peculiar structure, which is carried to a still more abnormal development in *Lepidosiren*. This view seems warranted by the theory of evolution, according to which air-breathing vertebrates must have been amongst later developments, and therefore have post-dated creatures with limbs more or less like those of Elasmobranchs and Teleosteans. The secondary

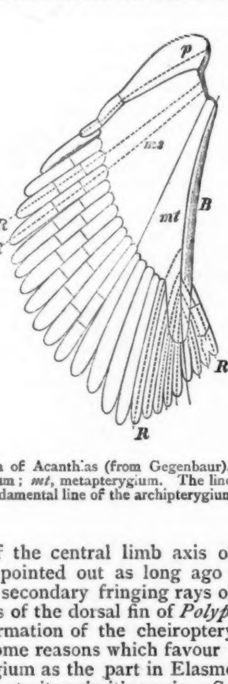


FIG. 17.—Pectoral fin of Acanthias (from Gegenbaur). *p*, propterygium; *ms*, mesopterygium; *mt*, metapterygium. The line drawn through *mt* indicates the fundamental line of the archipterygium or Ceratodus limb-axis.

fringing rays of the central limb axis of these Dipnoi may (as Peters pointed out as long ago as 1845) have arisen like the secondary fringing rays of the dorsal of the primary rays of the dorsal fin of *Polypterus*.

As to the formation of the cheiropterygium, I think that there are some reasons which favour the acceptance of the propterygium as the part in Elasmobranchs which has most relation to its primitive axis. Such are (1) the preaxial position, in the limb, of the line of the Propterygium—which is the line of support needed for the fore-limb of a quadruped which necessarily extends preaxiad, distally; (2) the apparently complete atrophy of the mesopterygium in *Chiloscyllium* and its partial atrophy in *Polypterus*, and other forms; (3) the large size of the propterygium in *Chimæra*, *Callorhynchus*, *Cestracion*, *Scyllium*, and *Pristiurus*.

On the whole, then, I feel much persuaded that vertebrate limbs have been formed as follows:—

1. Two continuous lateral longitudinal folds were developed, similar to dorsal and ventral median longitudinal folds.

[1] See *Trans.* Connecticut Academy, vol. iii.

[1] See "Morphol. Jahrbuch" vol. ii. 3rd Heft, p. 421, Pl. 29.

2. Separate, narrow, solid supports, in longitudinal series, with their long axis at right angles with the long axis of the body, were developed in varying extent in all these four longitudinal folds.

3. The longitudinal folds become interrupted variously, the lateral folds so as to form two prominences on each side the primitive paired limbs.

4. Each anterior paired limb increased in size more rapidly than the posterior limb.

5. The bases of the cartilaginous supports coalesced as was needed according to the respective practical needs of the different separate portions of the longitudinal folds, *i.e.*, the respective needs of the several fins.

6. Occasionally the dorsal rays coalesced proximally and sought centripetally adhesion to the skeletal axis.

7. The rays of the hinder paired limbs did so more constantly, and ultimately prolonged themselves inwards by mediad growths from their coalesced base till the piscine pelvic structures arose.

8. The pectoral rays with increasing development also coalesced proximally, and thence prolonging themselves inwards to seek a *point d'appui*, shot dorsad and ventrad to obtain a firm support, and at the same time to avoid the visceral cavity; thus they came to abut dorsally against the axial skeleton and to meet ventrally together in the middle line below.

9. The lateral fins, as they were applied to support the body on the ground, became elongated, segmented, and narrowed.

10. The distal end of the incipient cheiropterygium either preserved and enlarged pre-existing cartilages or developed fresh ones to serve fresh needs, and so grew into the developed cheiropterygium.

11. The pelvic limb acquired a solid connection with the axial skeleton—a pelvic girdle—through its need of a *point d'appui* as a locomotive organ on land.

12. The pelvic limb became also elongated, and when its function was quite similar to that of the pectoral limb its structure also became quite similar. It became segmented in a way generally parallel with the segmentation of the pectoral limb, yet in part inflected inversely owing to its different mode of use.

Vertebrate limbs then are specialised differentiations of primitively continuous lateral folds, and might, for all we see, have been more numerous than two on each side, just as there are sometimes several successive dorsal fins which are all differentiations of a primitively continuous dorsal fold. The paired limbs and azygos fins may thus be all viewed as different species of one fundamental set of parts, *pterygia*, the sum total of which may be spoken of as the *sympterygium*. The paired fins of fishes are related to the limbs of higher vertebrates as structures which have diverged from their primitive condition to a less degree, not only because the piscine body is, as a whole, a more primitive structure, but also because their fins are still used for locomotion in that medium in which their primeval form—the continuous lateral fold—was first developed.

The amount of adaptive modification supposed will perhaps appear to some persons to be excessive. But I believe that the excessive plasticity of animal organisms is in general too little appreciated—a plasticity which results in, and is evidenced by, the many instances of homoplasy—the independent origin of similar structures. The existence of these adaptive modifications points to the existence of an intra-organic activity, the laws of which have yet to be investigated. The instances of serial and bilateral homology before cited from comparative anatomy, pathology, and teratology, also concur in pointing to an intra-organic activity, the laws of which are as yet unknown. The notion of an "internal force" is very repugnant to some of my contemporaries, but it is impossible to banish the idea of innate powers and tendencies, the existence of which is manifested in the inorganic world as well as in the organic world. We cannot conceive the universe as consisting of atoms acted on indeed by external forces, but having no internal power of response to such actions; and in "physiological units" and "gemmules" we have (as Mr. Lewes has remarked) "given as an explanation that very power which was pronounced mysterious in larger organisms."

Mr. Lankester[1] speaks of each animal function, even reproduction, as being "explained by its chemical and physical constitution," and of "the possibility of development" being "solely due to the physico-chemical constitution of protoplasm;" but he does not give the explanation, nor show how such constitution by itself gives developmental power. But even if he did the puzzle would but recur—By what process of the survival of the fittest did the inorganic substances obtain their various structures and innate powers?

To my mind the presence of a special internal force is made evident by the process of development; and I am disposed to concur with Milne-Edwards when he says: "Dans l'organisme tout semble calculé en vue d'un résultat determiné, et l'harmonie des parties ne résulte pas de l'influence qu'elles peuvent exercer les unes sur les autres, mais de leur co-ordination sous l'empire d'une puissance commune, d'un plan preconçu, d'une force préexistante."

Science, as I understand it, clearly points to the existence in each animal of something more than an amalgam of physical forces, to a force or principle which is *intra-organic*, as heat is in red-hot iron or light in the glowing photosphere of the sun—one with it as the impress on stamped wax is one with the material bearing such impress, though we can ideally distinguish the two. This power or force immanent in each living body, or rather which is the force of the body living (considered in an abstract way), is of course unimaginable by us, since we cannot by imagination transcend experience; nothing can be imagined by us which has not wholly or in its parts been the subject of our sensible experience, and we can have no sensible experience of this force, save as a living body acting.

It is on this account sometimes thought reasonable to deny its existence as a "figment of the intellect," forgetting the supremacy of the intellect over sense. Though no knowledge is possible to us except as following upon sensation, yet the ground of all developed knowledge is not sensational, but intellectual; it reposes ultimately not on "feelings," but on thoughts. Even in verification by sensation it is the *intellect* which doubts, criticises, and judges the action and suggestions of the senses and imagination. If then we have *rational* grounds for the acceptance of such a purely *intellectual* conception, the poverty of our powers of *imagination* should be no bar to its acceptance. We are continually employing conceptions of the kind—such, *e.g.*, as number, being, substance, causes, &c.,—conceptions perfectly intelligible, though transcending the powers of the imagination.

If, then, we should conclude that each living animal possesses a special and peculiar intraorganic force, and if such force be the imminent cause of nutritional balancings, and thereby of the facts of serial and bilateral symmetry, is it not reasonable to refer to that same cause directly adaptive modifications which, within limits, take place in response to the actions of the environment. The presence of such innate activity has been eloquently proclaimed by Hartman, though I would repudiate the contradictory term "unconscious intelligence," and would explain it in a way which differs widely indeed from his. But if such a power is the active agent in such organic adaptations, is it not reasonable to refer to it the special variations which result in the formation of new species? This is the very activity for the existence of which I have elsewhere contended,

[1] *Quarterly Journal of Micros. Science*, October, 1877, pp. 432, 433.

and to which I have applied the term "specific genesis," and it is this which I am more and more persuaded is the determining agent in, and therefore the one true cause of, the origin of species.

ST. GEORGE MIVART

VARYING EXPERIENCES

I LOVE to repeat other people's experiments, and though not in the least doubting the accuracy of recorded observations in relation to bees, clover blossoms, and fertilisation, some years ago I covered patches with wire netting, to exclude the bees, for all, every flower I believe, perfected its seeds. I hope I have earned a reputation for accuracy in my statements of facts, and that it is not necessary for me to call witnesses. I will say here, however, that about that time I was visited by Dr. Sterry Hunt, ex-President of the American Association for the Advancement of Science, and together we uncovered one patch, and examined a few mature heads, with the result as above stated.

Recently I referred to Mr. Darwin's statement that one might as well sprinkle *Linum perenne* with so much inorganic dust as its own pollen, and stated that in my own garden a plant from the Rocky Mountains perfects seeds, and can only use its own pollen. An esteemed friend takes me to task[1] for this statement, remarking that I have overlooked that Mr. Darwin's facts are confirmed by Dr. Fritz Müller, in Brazil. This, in connection with remarks made on my clover experience, leads me to suppose that some believe I have offered the facts in opposition to those of Mr. Darwin. Nothing has been further from my thoughts. My point has been to show that plants or insects do not always behave in the same manner, on all occasions, and under all circumstances. I had an interesting illustration of this in March last. Having occasion to examine a large patch of chickweed (*Stellaria media*), I was surprised to find a number of honey-bees engaged in collecting pollen from them. For the past few years I have made a point of closely watching the behaviour of insects towards flowers, and I never saw honey-bees at work on chickweed before; I never heard of any one who has. I believe the chickweed has been given up to rigid self-fertilisation. Profusely among the chickweed grew *Draba verna*. The flowers of the two are about the same size, and both white, but the bees kept with strict exclusiveness to the chickweed. Yet I know that the Draba is not obnoxious to them, for in other years I have seen them at work on these flowers. Among them also were some *Capsella Bursa-pastoris* in bloom; but they also were passed by. I have never seen bees or any insects on the shepherd's purse, but from this chickweed experience it would not be safe to say none ever do visit them. The date of this visit of the bees was March 15, the thermometer 52°, spring scarcely begun, and only these three early plants in bloom.

I had a similar instance last autumn of the honey-bee's faith in the crust of bread theory rather than have no loaf at all. We had an open mild season, and towards Christmas, long after all other flowers were gone, the *Salvia splendens*, of which I employed a large number in the decoration of my grounds, was alone in flower. On warm days they were thronged with honey-bees, and I feel almost sure they had never visited my plants in other years when other flowers were to be had. The corolla tube is too long for the bees, so they had to bore the corolla from the outside. Boring from the outside is easy work for our large humble-bees. Almost all our flowers which offer the least obstruction to mouth entrance are robbed of their sweets in this manner. Even red clover is "tapped" by them in this way. But it was very hard work for the honey-bees, and I am sure that, only for the absence of other and easier worked flowers, I should not yet be able to say that I had seen the honey-bee bore from the outside of a flower, as the humble-bee generally does. There were white-flowered varieties of this species among the scarlet ones, but all were treated alike.

It seems to me that bees are not attracted to flowers by colour or fragrance merely, but that they are influenced by labour-saving ideas. A little experience teaches them how best to work in any species to advantage, and they will of course "make time" by keeping to this one till all are done. White varieties or scarlet varieties are all one to them, they can distinguish the species by other means than colour. And then they learn where to work to the best advantage, and only glean in poor fields after the richer harvest has been gathered. These considerations will naturally lead to different behaviour in different climates, and if I note these differences it is very far from my intention to offer them as contradicting the experiences of others; on the contrary, no one has a higher appreciation of their value.

THOMAS MEEHAN

Germantown, U.S.

[1] In *Silliman's Journal.*

OUR ASTRONOMICAL COLUMN

DOUBLE STARS.—In Gilliss's catalogue of 290 double stars formed from observations made at Santiago, Chile, during the U.S. Astronomical Expedition in the years 1850-52, the conspicuous star α Eridani (*Achernar*), is reported to have been seen double, the companion being of the seventh magnitude, faint blue, and preceding, 3″ south. We look in vain for mention of this companion-star in the observations of Herschel, Jacob, and Powell, and it is especially strange that it should not have been detected by the former during his sweeps with the 20-feet reflector at the Cape. The well-known binary p Eridani is less than 2° distant, consisting of two nearly equal components of between the sixth and seventh magnitude, and at first sight it might be inferred that by a typographical error the name of the star is wrongly given by Gilliss. His position, however, is that of α Eridani, and further we happen to possess measures of p Eridani by Jacob, at the precise epoch of the Santiago observation 1850·79, giving for the angle 268°·7, and distance 4″·32; the *comes* therefore could hardly be described as preceding, 3″ south, but might rather be said to precede on the parallel. This would indicate that the star intended is really *Achernar*, and it must be left for further observation to decide upon the accuracy or otherwise of the statement made by Gilliss. If the companion exists it would be of interest to know its present position; the proper motion of the principal star is very insignificant, and marked difference from Gilliss's description would be suspicious as showing a binary character. Still it is to be observed that there are considerable discordances between the angles and distances of many of the stars in the Santiago catalogue and those in Herschel's Cape volume. The former are not the results of actual micrometrical measures. It is stated that the catalogue was formed by plotting, on a large scale, the differences of right ascension and declination of the components of the double-stars observed with the transit-circle (4½ inches aperture), and then measuring from the drawings the angles of position and distances. In most cases the right ascensions and declinations observed are given in the preceding catalogue of 1,963 stars, and the results of the graphical process can be verified by calculation. In looking through the list of double-stars the reader will note differences from Herschel's data, which are not always easily explained by possible motion, though, as some of the stars have not been properly measured since Herschel's epoch, there will remain a doubt as to the cause of these differences. As instances in point, we may mention the following numbers of the Cape cata-

logue:—3860, 3966, 4119, 4281, 4538, 4667, and 4770. Probably Mr. Ellery at Melbourne, or Mr. Todd at Adelaide—both of whom are understood to be partially occupied with measures of the southern double-stars—may eventually clear up the uncertainties which characterise the results published by Gilliss.

While referring to the catalogue of stars observed at Santiago, it may be remarked that the majority of the large proper motions shown by comparison with Lacaille are proved to arise from errors of observation on his part, when we examine the particular cases with the aid of the valuable volumes which Mr. Stone is so regularly issuing from the Royal Observatory, Cape of Good Hope. When the volumes containing the observations made in 1876 (N.P.D. 135°–145°) and in 1877 (N.P.D. 125°–135°) are published, Mr. Stone will have placed in the hands of astronomers the means of investigating the proper motions of a large number of southern stars, which can hardly fail to lead to conclusions of much interest and importance. We are not justified in supposing that in Groombridge 1830 we have the case of largest proper motion in the northern hemisphere, and as to the proper motions of southern stars our knowledge is yet but very limited, and very conspicuous instances of rapid translation may remain to be detected amongst the telescopic stars of the southern heavens.

THE NEW COMET.—The telegram notifying the discovery of a new comet, and forwarded by the Smithsonian Institution to M. Mouchez, Director of the Observatory at Paris, is in these terms:—"Discovery, by Lewis Swift, of Rochester, of a large and faint comet, July 7, 1878, at 2h., in 17h. 40m. right ascension and 18° north declination, with slow motion towards the south-west; neither tail nor nucleus, but a central condensation. Query, is it the Tempel comet?" In communicating this telegram to the Academy of Sciences, on July 15, it was stated that the sky had been overcast at Paris, and therefore no opportunity had been afforded for verifying the discovery, and further that, notwithstanding an immediate intimation was given to the principal European observatories on receipt of the telegram at Paris on July 9, M. Mouchez had not heard of any observation elsewhere.

In this country several practised observers have failed to detect the comet, though the skies have been at times very favourable. The query in the American telegram, referring to Tempel's comet, might suggest that the declination of the comet was *south*, but, upon submitting the point to calculation, it does not appear that this change will afford an explanation of the want of success. If Tempel's comet were in perihelion about noon on August 11, its right ascension, at the time of Mr. Lewis Swift's discovery, would have been as he estimated it, but the declination would not be more than 7½° south. A large, faint, diffused nebulosity, however, is easily overlooked—the best chance of detection, when the position is not precisely known, being probably afforded with the "comet-seeker," by which we mean such an instrument as is (or was formerly) constructed by Pistor and Martins, of Berlin. Mr. Lewis Swift was already the independent discoverer of a comet, and is not likely to have been mistaken or misled by any optical illusion on this occasion.

[Since the above was written we learn that Prof. Winnecke re-observed the periodical comet of Tempel at Strasburg on July 20, the position obtained that evening indicating that the perihelion passage will not take place until September 6, or between five and six days later than the date fixed by M. Schulhof's calculations, which is, perhaps, as close an agreement as was to be expected, since the observations in 1873 did not suffice for the very accurate determination of the mean diurnal motion. The comet was from 2′—3′ in diameter, with nuclear condensation. When the mean anomaly is so corrected that the observed and computed longitudes for July 20 are made to agree, the latitudes differ only one minute, proving that M. Schulhof's other elements are very near the true ones. The following places for midnight at Greenwich may facilitate observations:—

	Right Ascension.	North Polar Distance.	Log. Distance from Earth.	Log. Distance from Sun.
	h. m. s.	° ′		
July 26	15 24 48	97 7	9·8708	0·1518
,, 30	15 30 25	98 48	9·8741	0·1476
Aug. 3	15 36 50	100 30	9·8777	0·1438
,, 7	15 44 2	102 14	9·8818	0·1402
,, 11	15 52 0	103 57	9·8861	0·1371
,, 15	16 0 42	105 40	9·8908	0·1343

The intensity of light does not sensibly vary during the above interval.]

METEOROLOGICAL NOTES

TO the meteorologist the recent discussions in Parliament and out of it regarding the salubriousness or insalubriousness of the climate of Cyprus have been, if not instructive, at least amusing, the amusement arising from the circumstance that positive information was not forthcoming in support of the strong statements made on both sides. Thanks, however, to the Scottish Meteorological Society, we have trustworthy information on the subject, that Society having established there one of its foreign climatological stations in 1866, where, for about four years, observations were made by Mr. J. B. Sandwith, H.M. Vice-Consul, and the results regularly published in the Society's *Journal*. Summarising these results, we learn that the annual rainfall is about 14 inches, nearly the whole of which falls from November to April, notably in November and December, that no rain falls in June, July, and August, and only trifling amounts, but occurring rarely, in May and September. There is thus practically five rainless months in the year in Cyprus, the rainless summers being a feature in its climate common, as we have recently had occasion to remark, to the climates of the Mediterranean regions south of latitude 43° (NATURE, vol. xviii. p. 287). Comparing it with the coasts of Syria opposite, its winters are milder and its summers cooler; and the decidedly insular character of its climate is further apparent from the fact that the coldest month is February, with a mean temperature of 52°·8, being about equal to that of London in the middle of May, and that the mean temperature of August is nearly as high as that of July, both being about 81°·0, which is approximately the summer temperature of Algiers, Alexandria, Athens, and Constantinople. During these four years the highest recorded temperature in the shade during any of the months was 96°·0, except June, 1869, when, from the 21st to the 25th, the mean temperature at Alethriko, 3½ miles inland from Larnaka, reached 95°·5, being about the average summer temperature of the Punjab, rising on the 24th to a maximum of 105°·0. On the same day the temperature rose to 100°·0 at Larnaka, and to 103°·5 at Jerusalem, 2,500 feet above the sea, the period being characterised as one of unprecedented heat and drought over the whole of the regions bordering the Levant. It is obvious to remark that much may be done in mitigation of the effects of the summer heat, just as has been done in countries similarly circumstanced, by the establishment of sanataria among the mountains, and by carrying through agricultural improvements and engineering works, which would at the same time contribute to the material prosperity of the island.

PROF. LOOMIS, in a ninth Contribution to Meteorology, handles admirably a question of first importance in

the practical bearings of the science, viz., the relations of the barometric depressions and storms of the Pacific States to the storms east of the Rocky Mountains. As regards the twenty-seven storms whose courses he has traced, it is probable that the great majority, if not the whole of them, were first formed over the Pacific Ocean. In each of the twenty-seven cases (with perhaps one single exception) the storm crossed the Rocky Mountains, and was thence tracked across the United States to the shores of the Atlantic, subject, however, in some cases to modification in its progress. It is scarcely possible to overrate the importance of these results in the practice of weather telegraphy and on questions affecting the general movements of the atmosphere. For we see here that an unbroken mountain-range of at least 6,000 feet in height does not stop the eastward progress of these barometric depressions and storms; neither do mountain-ranges of more than 10,000 feet in height, broken as in North America, present an insuperable obstacle to the onward course of these phenomena. The mountain-ranges between the Pacific and the Mississippi present obstructions to the formation of a system of winds of any great geographical extent; and hence, probably, barometric depressions are not so great over this uneven and broken region as over the vast plains of the Mississippi and eastern States, where there are no mountain barriers to interfere with the formation of a system of circulatory winds over areas 2,000 miles in diameter.

CHEMICAL NOTES

INFLUENCE OF TEMPERATURE ON THE ROTATORY POWER OF QUARTZ.—Following up the researches of Lang and Fizeau, Sohncké has found (*Ann. d. Phys. Chem.*, N.S. III. p. 516) that the increase in rotary power in quartz, with increase of temperature, is not directly proportional to the temperature, but is less at lower than at higher temperatures. For the crystal he experimented on he determined the following formula:—

$$\phi = \phi^\circ (1 + 0{\cdot}0000999\, t + 0{\cdot}000000318\, t^2),$$

where ϕ° = the rotatory power of the same crystal at 0°; and he further found that the relative increase of power in the plane of polarisation was the same for all colours up to 170°. To see whether the octahedral system presented the same phenomena he also examined common salt, and obtained similar but more strongly-marked results.

CHANGE OF INDICES OF REFRACTION IN MIXTURES OF ISOMORPHOUS SALTS.—M. Dufet, in the *Comptes Rendus*, lxxxvi. 881, gives a most interesting account of some experiments he has carried out on the above subject, partly in continuation of such work as that of Senarmont, Topsoë, and Christiansen (*Ann. Chem. Pharm.*, 1874). Instead of examining simple isomorphous salts the author has taken mixtures containing varying quantities of magnesium and nickel sulphates, but of known composition. Working with such bodies he has determined that "the differences between the indices of a mixture of two isomorphous salts and those of the component salts are inversely proportional to the number of equivalents of the two salts entering into the mixture." In his calculation, M. Dufet has taken as an equivalent the number 111 or one equivalent of $SO_4.7HO$. He considers the law of variation of the index as a consequence of Gladstone's law: the refractive energy $\frac{n-1}{D}$ of a mixture of two bodies with no chemical action on one another, being the sum of the refractive energy of the component substances. According to M. Dufet, isomorphous salts crystallising together, form mixtures presenting analogies to a certain extent comparable with liquid mixtures, where the physical properties are the mean of those of the components; this, however, is only true up to a certain point.

ALLOTROPIC MODIFICATION OF COPPER.—By the electrolysis of a solution of about 10 per cent. of copper acetate Schützenberger has obtained an allotropic variety of copper somewhat remarkable in its physical and chemical properties. During the electrolysis the surface of the negative platinum electrode which faces the positive copper electrode becomes covered with a layer of the allotropic modification of the metal, whilst the other side of the electrode is covered with a deposit of ordinary copper. The allotropic modification forms metallic glittering scales with roughened surfaces on the side next the solution; should the electrolysis be carried on long enough, beautiful tree-like forms are deposited on the edge of the negative electrode, which gradually ramify over to the positive electrode. The allotropic copper is less red than the ordinary variety, possesses surfaces without malleability, and can be reduced to an extremely fine powder. Its density, 8 to 8·2, is higher than that of the ordinary variety, which is about 6·9. It oxidises rapidly in the air, becoming at once iridescent, and finally of an indigo blue colour; when exposed to the air as a powder it becomes black, changing finally into the oxide. According to the author it becomes reconverted into the ordinary form of copper by heat, or exposure to certain chemical agents.

SACCHAROSE.—M. J. Motten has recently brought forward a paper, entitled a "Contribution to the History of Sugar (Saccharose)," in which the author discusses the action of light and of a temperature of 100° Cels. on solid and dissolved sugar, proving that the light alone does not invert dissolved sugar, and also that a temperature of 100° does not alter dry sugar. On the other hand solid sugar imperfectly dried, and dissolved sugar are altered under the influence of that temperature; oxygen is then absorbed, and carbonic acid evolved, but more slowly than it was often supposed.

HEAT EVOLVED IN THE FORMATION OF ISOMERIC BODIES.—M. Berthelot has given several communications to the Chemical Society of Paris, relating to the above subject. He finds that in general nitro compounds and isomeric nitric ethers appear to be formed with the disengagement of very unequal quantities of heat; the transformation of ethers into nitro compounds disengage approximately thirty heat units, at the same time undergoing increase of density and rise in the boiling point. In the case of metameric acids, as butyric, isobutyric, valerianic, &c., combining with the same base, his numbers show that the heat disengaged is precisely the same in the various cases which he describes. Approximately equal numbers are also obtained in the case of the chloro and bromo derivatives of these acids. There is very little difference also in the heat disengaged in the transformation of isomeric alcohols into isomeric aldehydes. The general results of his experiments, covering about thirty compounds, including alcohols, aldehydes, fatty acids, and their salts, chloro and bromo acids, &c., point to the conclusion that isomeric bodies having the same chemical function are formed with nearly identical disengagements of heat, their reciprocal metamorphosis disengaging very little heat. Finally, the same approximations exist in the formation of their isomeric derivatives.

CHEMICAL CHANGES TAKING PLACE DURING THE RIPENING OF GRAPES.—From experiments lately made on the transformations of the grape, and the exchanges between it and the surrounding atmosphere, MM. Saint Pierre and Magnien conclude that grapes at the time of their maturation liberate carbonic acid both in darkness and in light, the quantity produced being always superior to the quantity of oxygen consumed, if the experiment be long enough. This liberation occurs as well in an inert

gas as in air. Grapes are capable of absorbing or losing water when kept in a moist medium or in a dry medium. As maturation advances, the acids diminish and the sugar increases. The mechanism of maturation is stated to be this:—Acids and glucose are formed in the plant, and the sap conducts them to the grape; the acids are consumed in it, while the sugar is concentrated. When the maturation is very advanced, the sugar is consumed in its turn.

RIPENING OF GRAPES AFTER REMOVAL FROM THE VINE.—In the *Gazetta chimica Italiana*, vii. 517, some experiments by M. Pollacci are described, in which he finds that the process of ripening continues for a certain time after the grape has been removed from the parent plant. The bunches of fruit removed were, as far as possible, equally divided, and the quantity of glucose and acid determined in the freshly-gathered grapes, as also in portions kept in the shade for some ten or twelve days. In all the portions which had been kept, the glucose had increased, whilst the amount of acid had diminished, showing that a certain amount of ripening action had taken place; this action, however, ceases after a time, the ripening never attaining full maturity.

USE OF METHYL CHLORIDE FOR THE PRODUCTION OF LOW TEMPERATURES.—At a recent meeting of the French Physical Society, M. Vincent called attention to the use of chloride of methyl for production of low temperatures. It may be extracted in large quantities and cheaply from the products of beet-root molasses. It is normally gaseous, and liquefies under about four atmospheres pressure, when it may be conveniently carried about in iron or copper vessels, a store of cold at easy disposal. On opening a cock the liquid will flow out and give a bath at $-23°$, its boiling temperature under atmospheric pressure. If the vaporisation be intensified by a current of air, the temperature descends to about $-55°$. M. Vincent has arranged an apparatus for utilisation of such cold. He incloses two or three kilogrammes of liquid chloride of methyl in a double wall enveloping a bath of alcohol or chloride of calcium in solution, and protected exteriorly by an isolating layer of cork raspings. To obtain low temperatures, a cock is opened to allow communication of the double envelope (through a caoutchouc tube) with an air-pump.

FORMATION OF HYDROCARBONS BY THE ACTION OF WATER ON MANGANESE IRON ALLOYS CONTAINING CARBON.—Cloëz found that by acting on Spiegeleisen with dilute sulphuric acid bodies resembling the petroleum hydrocarbons were formed. On trying the action of pure water at 100° no results were obtained, while at 250° with super-heated steam, a certain action was perceived which increased with the temperature, being completed at a dark red. The hydrocarbons, however, were again decomposed. The same author has since tested a series of manganese alloys, and finds that the best results are obtained by means of one containing roughly Mn 85, Fe 6, C 3·5, Graphite 4, Si 1·1. Small portions of this, treated with boiling water, decomposed the latter with the evolution of hydrogen, oily drops being simultaneously formed, and the gas burning with a luminous flame showed the presence of hydrocarbons. Another alloy of nearly similar composition gave the following results: the flask contained slightly alkaline water with a mixture of iron and manganese oxides in suspension; the liquid hydrocarbons in the condenser were similar to those previously found, the gases also burning with luminous flames. He has thus shown that water alone at the proper temperature decomposes manganese iron alloys containing carbon.

ACTION OF BORON FLUORIDE ON CERTAIN CLASSES OF ORGANIC COMPOUNDS.—This body has been found by Fr. Landolph to combine in definite proportions, equivalent for equivalent, with certain classes of organic bodies such as aldehydes, acetones, and also with camphor. For his experiments the particular substances examined were ethylic, valeric, and benzylic aldehydes, ordinary acetone, euodic aldehyde (oil of rue), and ordinary camphor. In all these cases considerable disengagement of heat was manifested in the combinations of the several substances. By the action of the fluoride on acetone two products are obtained, the one boiling between 130°-140°, this being, according to the author, the most definite; another compound, however, exists which boils at a temperature of 160°-170°. The first is a fluid of a syrupy consistence and yellow-green colour; it burns readily, giving a green flame, and is entirely decomposed by water. The compound, with ethylic aldehyde, ethylen fluoboride, $C_2H_3BFl_2$, undergoes decomposition when treated with water, into a body with a peculiar ethereal odour, the composition of which, the author thinks, may probably be C_2H_5Fl.

GEOGRAPHICAL NOTES

IN the just-published number of the Royal Geographical Society's *Proceedings* we find some useful remarks by Mr. F. Galton, on what has recently been done and what is further required for the advancement of geographical teaching. First and foremost, he says, is the publication of that excellent book by Prof. Huxley, "Physiography," which, starting from the simplest elements, led students steadily on to the higher conception of physical geography and the most recent discoveries in it. Next, Sir Walter Trevelyan, a former Secretary of the Society, had felt so much the necessity of a better form of text-book for geographical teaching that he had placed a handsome sum at the disposal of the Council to procure, if they were able to do so, the compilation of a really good county geography, to serve as an example for other similar works to be used in elementary schools. Turning to what is required in the future, Mr. Galton mentions that they have received a letter from a master of one of the great public schools, urging them to plan a system of diagrams explanatory of different physical features. His own opinion, Mr. Galton says, is that what is most urgently needed is some simple and well-methodised system of experiments, suited to illustrate lectures on the main features of physical geography. He has no doubt that an extension of the methods of illustrating the facts of physical geography—as used by Prof. Tyndall and Dr. Carpenter—on a small scale and on a lecture-room table, is perfectly feasible. Thus, as every thunder-shower shows in the streets the phenomena of erosion and deposition, he has no doubt that, on a lecture-table, with a can to supply water, and with a certain quantity of sand, gravel, and clay, all the main phenomena of river-action, such as the sifting of materials, the stratification of deposits, and the formation of deltas, might be successfully shown.

MEANS have recently been found, we learn from the *South Australian Register*, for still further increasing the usefulness of the Hon. (now Sir) T. Elder's camels on the far northern stations with which he is connected. The experiment of using them for draught purposes has been tried, and recently two teams of six camels drew loads of 5¼ tons each from Beltana to Port Augusta. The plan adopted is to yoke the animals together something after the manner in which bullocks are coupled, and one man only is required to manage each team. It has been found that the camels thrive well in the northern country; the number originally imported several years ago was about 100, of which the greater part died, as the land, by its comparative richness, presented too great a contrast to their native soil; there are now, however, about 400 of their descendants at Lake Hope, Umberatana, Beltana, and other stations in the far north, and the race seems to be thoroughly acclimatised. The camels have already been

found to be of great service in exploring expeditions, and they are still being used by parties engaged in opening up new pastoral country. Several of the animals have recently been lent to squatters for expeditions to the country on the Western Australian border, the MacDonnell ranges in Central Australia, and elsewhere.

FROM the new issue of Behm and Wagner's "Bevölkerung der Erde," we learn that the present population of the earth is estimated at 1,439 millions as compared with 1,424 millions given in the previous issue. This increase results mainly from the recent censuses which have been taken in several countries. This population is divided among the several continents as follows:—Europe, 312,398,480; Asia, 831,000,000; Africa, 205,219,500; Australia and Polynesia, 4,411,300; America, 86,116,000. This new issue contains the first map we have seen of New Zealand with the recent division into counties, in substitution for the old division into provinces. A census according to counties cannot, however, be taken till 1881. The North Island has thirty-three and the South Island thirty-one counties.

MR. STANFORD has issued a very useful shilling Treaty Map of South-Eastern Europe and Armenia, showing the boundaries of the New Bulgaria and Eastern Roumelia, the accessions to Austria, Russia, Montenegro, Servia, and Roumania, and all the other changes which have been made by the recent Congress. The new features are shown with unmistakable clearness. Mr. Stanford is also preparing a large scale map of Cyprus, showing not only the physical, but also the geological, agricultural, and other features of our latest acquisition.

AN expedition to the mouth of the Yenisei River left St. Petersburg last week. Principally at the instigation of a Moscow commercial firm eight steamers laden with corn, spirits, nitre, and other goods will soon start on the new sea-road to Siberia, their return cargoes consisting of wood and tea.

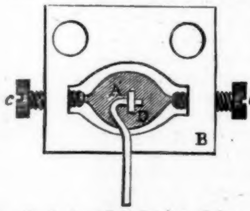
MR. GORDON BENNETT proposes to send the yacht *Dauntless* on a voyage of discovery to the Polar Seas, *viâ* Spitzbergen, in addition to the *Pandora*, which will attempt to reach the Pole by another route.

A METHOD OF RECORDING ARTICULATE VIBRATIONS BY MEANS OF PHOTOGRAPHY[1]

THE object of this paper is to describe a method of obtaining photographs of minute vibrations on a magnified scale.

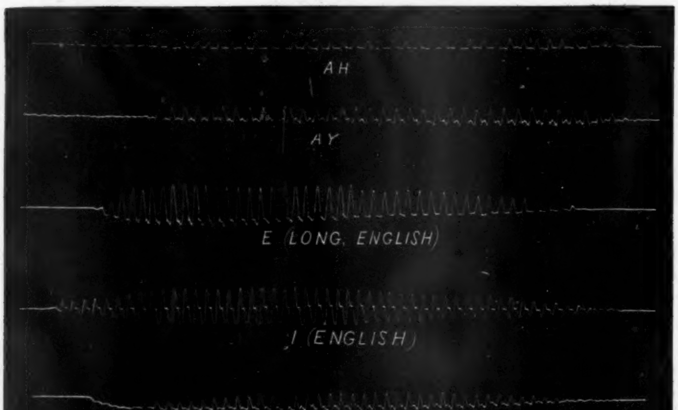
A plane mirror of steel, A, is supported by its axis in the metal frame B. The ends of the axis are conical, and carefully fitted into sockets in the ends of the screws C, C. On the back of the mirror is a slight projection, D, pierced by a small hole.

The vibrating disc, as hitherto employed, is a circular plate of ferrotype iron, 2¾ inches in diameter, screwed to the back of a telephone mouthpiece of the form invented by Prof. John Peirce, and now universally used. From the centre of the back of this disc a stiff steel wire projects, the end of which is bent at a right angle. This wire serves to connect the vibrating disc



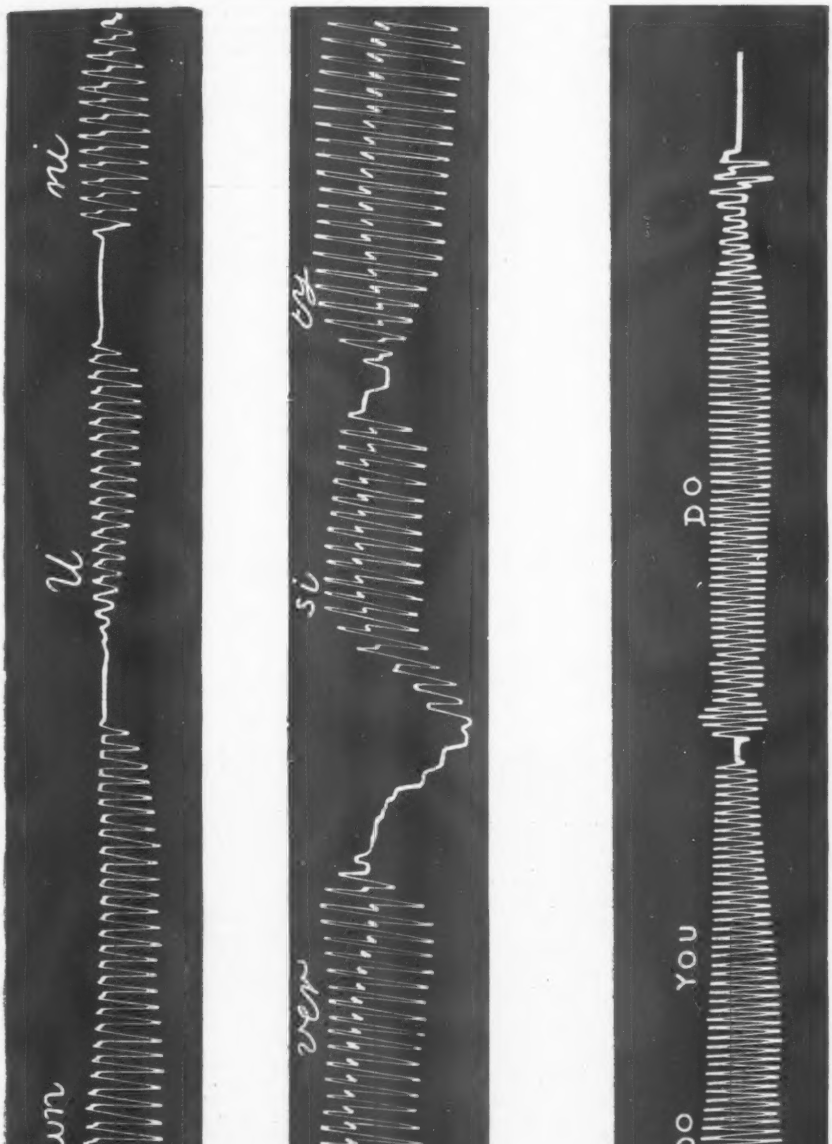
Back view of mirror, actual size.

with the mirror by hooking into the hole in D, as represented in the figure. The mirror frame and the vibrating disc are kept in a fixed relation to each other by a block of hard wood, to which both are firmly screwed. The mirror is set with its axis parallel, and its reflecting surface perpendicular, to the vibrating disc.



A heliostat sends a beam of sunlight horizontally through a small circular opening. This beam passes into a dark closet, and at a distance of several feet from the circular opening falls upon the mirror above described, placed with its axis inclined 45° to the horizon. The rays, reflected vertically downward, pass through a lens at whose focus they form an intensely luminous image of the circular opening.

[1] The text abridged for NATURE by Prof. E. W. Blake, of Brown University, from a paper in the *American Journal* for July. The illustrations (except mirror) from photos supplied by Prof. Blake.


Brown
U
ni
ver
si
ty
HOW
DO
YOU
DO

A carriage moving smoothly on four wheels travels beneath the lens at such a distance that the sensitised plate laid upon it comes at the focus for actinic rays. A uniform velocity is given to the carriage by a string fastened to it and passing over a pulley. To this string a lead weight, just sufficient to balance friction, is permanently attached, while a supplemental weight acts at the beginning of motion and is removed just before the sensitised plate reaches the spot of light above described.

The velocity attained by the carriage is determined by placing a sheet of smoked glass upon it and letting it run under a tuning-fork (Ut. 3—512 v. s.) provided with a pointed wire. In every case more than 200 vibrations were counted and measured, and careful comparisons made between the earlier and later ones, so as to be certain of the uniformity of the motion.

From the description it will be evident that when the carriage alone is in motion a straight line will be photographed upon the plate. On speaking into the mouthpiece the disc is set in vibration, each movement causing change of angular position of the mirror, the reflected light moves through twice this angle, and the resulting photograph gives us the combination of its motion with that of the carriage. The carriage should run from *right* to *left*. The negative (examined from the *glass* side), and prints taken from it, then give the syllables in their proper order, and show movements of the disc from the speaker by lines going from the observer. The arrangement of my dark room compelled me to make my carriage move from *left* to *right;* hence, in the figures given, forward positions of the disc are represented by the lower portions of the curves.

The general character of the curves obtained is shown in the accompanying figures, which are the actual size of the originals, except that representing the vowel-sounds, which is about one-half (0·56).

The velocity of the carriage for the vowel-sounds was $21\frac{1}{2}$, for *Brown University*, 40, and for *How do you do*, 14 inches per second.

In the mathematical discussion of these curves the abscissas are measured by the known velocity of the carriage, and serve to determine the *pitch*, the ordinates represent the amplitude of vibration of the centre of the disc, magnified 200 times in the photographs. The reduction of scale makes the magnifying in the woodcuts only 112 times.

The ordinates are not strictly straight lines, but parts of the vertex of a parabola, and closely approximate to circular arcs whose radius is the focal length of the lens employed. In the figures given, the centres of curvature of these arcs is at the right hand.

With an ordinary tone of voice an amplitude of nearly an inch is obtained, implying a movement of the centre of the disc of ·005 inches as determined by actual measurement.

By varying the accelerating weight and its fall, any manageable velocity may be given to the carriage. Each syllable requires for its articulation about one-fourth of a second, hence the plates must be quite long when the velocity is great. I employ plates two feet in length, and find that velocities from 16 to 40 inches per second give good results. The action of the light is, however, inversely as the velocity. To compensate for this, the size of the circular opening admitting the light may be increased. This, of course, causes an enlargement of the luminous image, and apparently involves an injurious widening of the line traced, but, as observed by Dr. Stein in his experiments, the effect of velocity is to narrow the line photographed, since the maximum exposure is in that diameter of the circular image which lies in the line of motion. This is a great advantage, since a variation of velocity in the vibration is marked by the widening of the line, often more clearly than by the form of the curve.

I have employed the ordinary photographic process, not attempting to obtain special sensitiveness. The brightest sunlight is required, a slight haziness interfering seriously with the result. My heliostat employs two reflectors of ordinary looking-glass, and the loss of light is considerable.

Are *all* the audible elements of speech traceable in these records? in other words, is the record complete? I am not prepared as yet to answer this question definitely, but the following experiment leads me to doubt whether an affirmative answer can be given, while at the same time it illustrates in a striking manner the sensitiveness of the ear. The mirror was attached to the disk of a *receiving* telephone and a photograph taken from it while the instrument was talking audibly. The resulting record was almost a smooth line, showing but very slight indications of movement of the mirror. It would therefore appear that there are distinctly audible elements, which are too minute to be recorded by this method. It is to be noted, however, that the width of the line traced where the vibrations are extremely small, is so great as to mask the curvature, so that the experiment just cited is not entirely fair.

The clearness and beauty of the curves obtained can hardly be appreciated without inspection of the originals. Their complexity and variety open a large field for investigation, and they seem to offer the means of analysis of articulate speech.

THE PHONOGRAPH AND VOWEL SOUNDS

I.—The Vowel Sound ō.

In a recent letter to Nature we gave a short account of what we believed to be the existing theories of vowel-sounds. In the present paper we will state the chief results as to the vowel *ō* of our investigations made by means of the phonograph.

The experiments were made as follows:—The vowel under consideration was spoken or sung at a given pitch, determined by a piano, while the barrel of the phonograph was turned at a definite speed, regulated by means of a metronome. The indentations made in the tin-foil were then mechanically transcribed, so as to give curves representing a magnified section of the impressions. The curves were magnified by a system of compound levers, and recorded by an arrangement resembling that of Sir William Thomson's siphon-recorder. The details of the apparatus are described in a paper laid by us before the Royal Society of Edinburgh. The vertical ordinates of the curves drawn in ink, as shown below, are about 400 times larger than the corresponding indentations in the tin-foil, while the longitudinal ordinates are multiplied about seven times. The slowness of the motion by which the transcript was made enabled us to avoid all error due to inertia of the working parts, and the total absence of friction between the marking siphon and the paper allowed the transcript to be made without employing such a pressure on the tin-foil as would sensibly alter the indented curves. This fact was in each case tested by making the phonograph speak the vowel after it had been copied. All transcripts were rejected if the tin-foil did not continue to give the sound clearly after being used to produce these curves.

We employed various sizes of chamber and of mouth-piece, various thicknesses of tin-foil, and various discs as receivers. The curves now given as transcripts were found to be practically independent of variations in all these conditions. We are therefore of opinion that the curves do really represent the motion of an air-particle when the vowel is spoken, and that these curves may be regarded as sufficiently unaffected by any periods of vibration proper to the disc and springs employed, or to the air in the chamber of the mouth-piece, to constitute a true record of the essential parts of the vowel-sounds. This may be inferred from the remarkable constancy in the results obtained, with great variations in the conditions of the experiment, and from the fact that the indentations, after being copied, were in each instance able to give back the vowel-sound distinctly.

Fig. 1 gives a series of curves produced by a single baritone voice singing *ō* on a series of notes ranging from G to *f'*. This series has been selected because the voice was of good quality and considerable range.

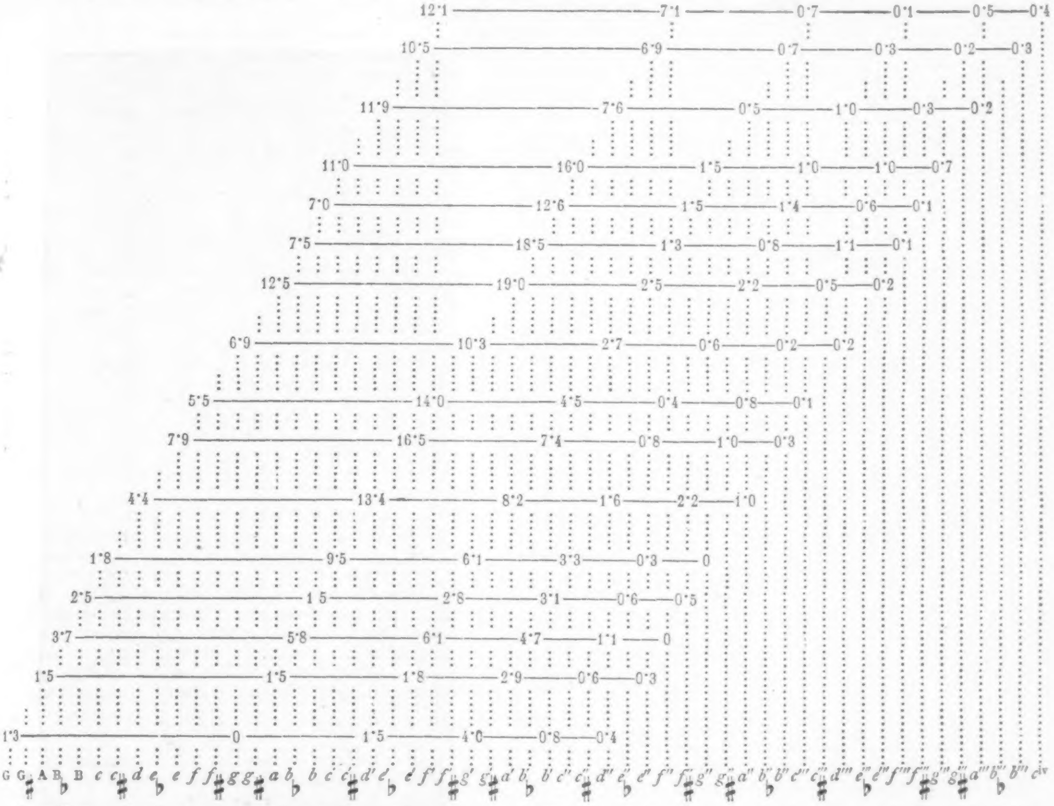
After the curves were obtained they were subjected to harmonic analysis. One period was divided into twelve equal parts, and twelve ordinates were drawn and measured at right angles to a line joining two successive maximums or minimums. The numbers so determined enabled us to calculate the amplitudes of the first *six* partial tones.

Table I. gives these amplitudes for the above series of *ō*'s, obtained by analysing one period chosen out of the hundreds of similar periods which were given by each utterance. An examination of the curves and of the table will show that the change in character from note to note is fairly gradual and consistent throughout. The figures are arranged so as to show the absolute pitch of each of the six partial tones.

Voices of very different qualities were tested in the same way throughout the same range or such parts of that range as were within their compass.

Too much space would be taken up if we were to give here all the results obtained. It may be briefly said that the several voices agreed very fairly in respect of the partials composing the vowel at each pitch, that is to say, throughout the range

TABLE I.—*Amplitudes of the Harmonic Constituents of the Vowel Sound ō Sung at Various Pitches by the same Voice.*



from f' to g the first and second partials are the main components; from f to d the third partial is prominent, and about c the fourth partial becomes strong. At G, in one voice, the fifth partial was strong, whereas in the example now given it was weak.

When the several voices were compared in respect of the relative strength of the partials, it became clear that this relative strength might vary greatly without affecting the vowel quality much.

This is brought out by Table II., which contains the constituents of $\bar{o}$ as sung by five different voices on five different notes. The figures are proportional to the actual amplitudes of each harmonic constituent, and therefore not only show the relative value of each constituent in a given vowel, but also indicate (although only very roughly) the strength of the several voices on each note. Those constituents which are most considerable are printed in large type. Those printed in small type may perhaps be regarded as accidental and not essential to the vowel sound.

On e' the vowel sound is composed of the two first partials, but with different voices these were present in proportions which varied from $\frac{100}{102}$ to $\frac{100}{34}$.

On c' the vowel sound was still composed almost wholly of the two first partials, and with different voices these were present in proportions which varied from $\frac{100}{145}$ to $\frac{100}{46}$. From this it is evident that the vowel sound may vary very slightly as a vowel when the proportions of its constituents vary largely. No doubt it may be said that the vowels pronounced were different vowels, but it must be remembered that each man was at least trying to sing the same vowel and was controlled by the same observers, who were satisfied that he did sing generically the same vowel.

On the other hand, the quality of the voices was extremely different. Voice No. 1 was a fine, powerful, trained baritone. No. 2 was a high-pitched voice with no notes below f, rather harsh, and unaccustomed to singing. No. 3 was the trained bass voice of a man of eighty. Nos. 4 and 5 were voices of average range and moderate power, with some musical training. No. 6 was a powerful bass. The differences in the proportions of the constituents appear to us therefore to indicate differences in the quality of the voices rather than differences in the vowel.

On c' the two first partials give a good $\bar{o}$, whether the second is one and a half times as big as the prime or the prime twice as big as the second.

The results on a and b do not differ much from those on c'; when, however, we come to g, the table shows us that while two out of the five voices formed their $\bar{o}$ by producing two partials as in the case of the higher notes, three other voices introduced a considerable third partial. On descending one tone lower, to f, we find that all the voices agree in employing a strong third partial. This third partial is sometimes less than half the prime, but it is never so small as one-third, and in one case it is sensibly larger than the prime. It would also be observed that it was the voice No. 5, which had no sensible third on g which gave the largest third on f. It should also be noted that the smallest third is due to voice No. 4, which was at the end of its range, and spoke or sang half a tone sharp.

As we descend below f the third assumes more and more prominence; on d voices 1 and 5 gave the following series of partials :—

	I.	II.	III.	IV.	V.	VI.
1°	4·4	13·4	8·2	1·6	2·2	1·0
5°	3·3	7·2	5·6	0·5	0·7	0·2

Table II. shows that by the time B is reached the fourth partial has become very prominent.

TABLE II.—*Harmonic Constituents of ō as Sung by different Voices.*

Note on which the vowel was sung.	No. of voice.	Amplitudes of the first six partial tones.					
		I.	II.	III.	IV.	V.	VI.
e'	1	10·5	6·9	0·7	0·2	0·3	0·2
	2	5·1	3·0	0·5	0·2	0·1	0·1
	3	5·3	1·8	0·3	0·1	0·2	0·1
	4	5·5	3·4	0·7	0·2	0·2	0
	5	5·2	5·3	0·5	0·6	0·5	0·2
c'	1	11·0	16·0	1·5	1·0	1·0	0·7
	[*b*] 2	[4·5	6·6	0·7	0·4	0·6	0·2]
	3	3·7	3·0	0·1	0·4	0·1	0·1
	4	5·4	2·5	0	0·3	0·2	0·1
	5	4·7	4·1	0·5	0·3	0·3	0·2
g	1	6·9	10·3	2·7	0·6	0·2	0·2
	2	2·3	5·1	1·4	0·3	0·2	0·2
	3	4·6	2·9	0·2	0·2	0·2	0·1
	4	3·3	4·4	0·7	0·2	0·1	0·2
	5	3·2	5·0	0·3	0·6	0·1	0·2
f	1	5·5	14·0	4·5	0·4	0·8	0·1
	[*f*♯] 2	[1·8	5·8	1·5	0·3	0·1	0]
	3	2·5	3·7	1·1	0·3	0·4	0·2
	[*f*♯] 4	[2·8	6·2	1·0	0·2	0·3	0·2]
	5	2·5	2·8	3·8	0·4	0·5	0·1
B	1	2·5	1·4	2·8	3·1	0·6	0·5
	2	Wanting.					
	3	2·1	4·6	2·9	2·8	1·0	0·[illegible]
	4	Wanting.					
	5	0·6	3·8	2·3	2·5	0·6	0·3
	[B♭] 6	[1·8	2·2	3·2	7·5	0·9	0·2]

NOTE.—The analyses put within brackets are a semitone different in pitch from the others in the group, and have their pitch marked at the side. They have been taken where there did not happen to be an example on the exact pitch wanted.

On G voice 1 gave the following series :—

1·0 1·3 0 1·5 4·0 0·8 0·4,

On F another voice (No. 6) gave

6·0 2·2 1·0 1·5 0·8 3·4 0·1.

In this last example we see that the fifth partial was much greater than the prime.

For the sake of brevity we have only given a few cases. Our results contain the analyses of more than a hundred curves, from which we have given what we think fairly representative examples. Moreover, the curves analysed were in many instances chosen from numerous examples, so as to represent not one experiment, but several. We will now state the results arrived at in somewhat more general terms.

1. At those pitches commonly employed in conversation the sound *ō* consists essentially of the first two partials of the note employed. The proportions between these partials may vary between 1 : 1·5 and 1 : 0·5; perhaps even more widely. When curves obtained by speaking were compared with those obtained by singing the proportions were much more nearly alike than could have been expected. The spoken *ō* differed chiefly from the singing *ō* by a continuous change of pitch, and also by running into an *ū* towards the end of the utterance.

2. When *ō* is sung from *g* downwards the third, fourth, and fifth partials appear in succession in such a way as to keep that which is the highest prominent partial not far from *b'*♭, which is called by Helmholtz the characteristic tone of *ō*. Above *g* the second and strongly reinforced partial lies in a region varying from three semitones below *b'*♭ to six semitones above it.

3. Until we reach the lowest notes G and A all the partials between the prime and the highest prominent partial are more or less reinforced. Thus *ō* successively consists of the first *two* partials, the first *three* partials, and the first *four* partials. On very low notes we have insufficient data for very positive conclusions, but the second partial seems to sink into insignificance as the fifth comes in.

4. The appearance of new partials as we descend the scale is in some cases and with some voices gradual; in other cases it is singularly abrupt.

Wave-form of ō Sung by the same Voice at Various Pitches.

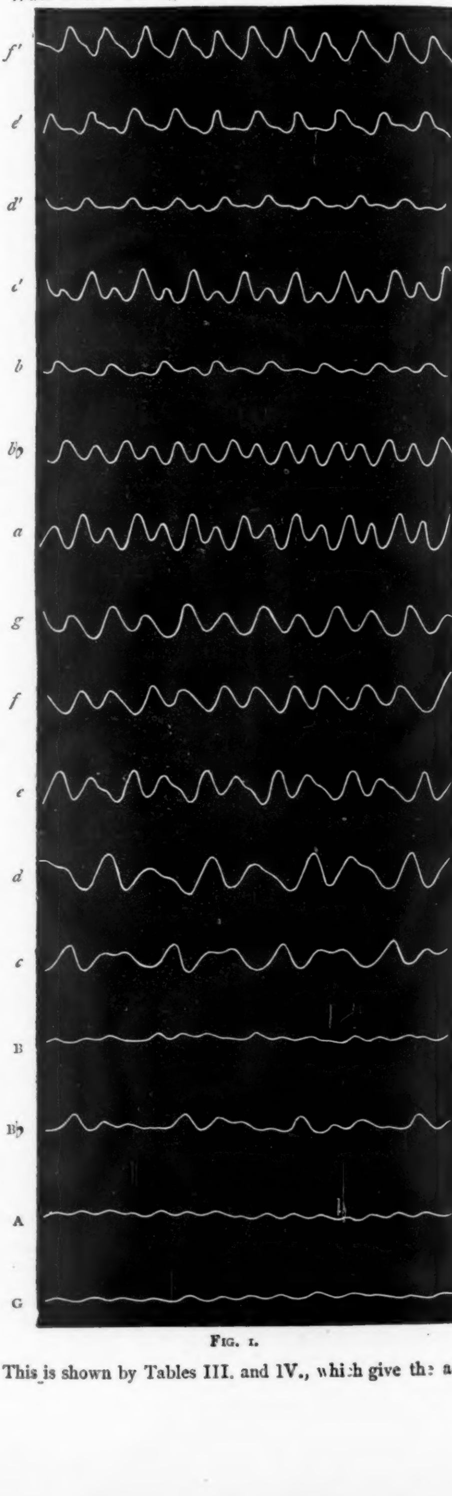


FIG. 1.

This is shown by Tables III. and IV., which give the actual

amplitudes of the third and fourth partials for voices 1, 3, and 5 at various pitches. The place where a somewhat sudden change happens is marked by a vertical bar.

TABLE III.—*Third Partials.*

Pitch of third partial.	*g''*	*f''♯*	*f''*	*e''*	*d''*	*c''*	*b'*	*a'*	*g'*	*f'♯*	*f'*	*e'*
Voice 1	1·5	1·5	1·3	2·5	2·7	4·5	7·3	8·2	6·1	2·8	6·1	1·1
,, 3	0·1	0·2	—	0·4	0·2	1·1	│3·5	—	4·6	2·9	2·5	3·5
,, 5	0·5	0·2	1·3	1·0	0·3	│5·8	6·4	5·6	—	2·3	1·5	2·2

TABLE IV.—*Fourth Partials.*

Pitch of fourth partial.	*c'''*	*b''*	*b''♭*	*a''*	*g''*	*f''*	*e''*	*d''*	*c''*	*b'*	*b'♭*	*a'*
Voice 1	1·0	1·4	0·8	2·2	0·6	0·4	0·7	1·6	3·3	3·1	4·7	2·9
,, 3	0·4	0·4	—	0·4	0·2	0·3	0·5	—	│3·5	2·8	3·6	3·9
,, 5	0·3	1·4	0·7	0·8	0·6	1·3	1·3	0·5	—	│2·5	1·5	2·1

It will be seen that the third partial springs into prominence more suddenly with voices 3 and 5 than with voice 1, but there is a rapid increase with voice 1, where the sudden change occurs with the other voices. This want of continuity suggests an adjustment or tuning of the mouth cavity, an idea which receives support from experiments on the sound *ū*, to be afterwards described.

Another very marked example of this sudden introduction of a new partial was given by voice 6, a powerful bass.

Note sung	B♭	A	G	F
Fourth partial ...	7·5	8·0	4·5	│ 0·8
Fifth partial ...	0·9	1·2	0·9	│ 3·4

The apparent tuning of the mouth cavity required to produce the sudden introduction of a new partial might perhaps be described as the involuntary selection of a new *ō* of different quality, but better adapted to be sung on the new note. We do not reject this mode of considering the phenomenon, but at the same time point out that there is a generic property common to the *ō*'s above and below the critical notes which leads us to regard all the varieties as sensibly one and the same vowel sound. Our experiments do not so far show whether any tuning takes place in the upper part of the scale, where nothing but a prime and its octave are present.

5. Whenever a partial falls on *b'♭* we find that it is specially prominent. This fact was ascertained by Helmholtz; and the confirmation of his experiments by a completely different method is very satisfactory, both as showing that the letter *ō*, as pronounced by the English and German singers, did not differ sensibly, and as tending to justify our confidence in the method of investigation which we have followed. In that part of the scale where the vowel consists simply of the prime and its octave, the second partial, when it falls on *b'♭*, is usually a maximum, both absolutely and relatively to the prime. This result was to be expected from the experiments of Helmholtz and Donders.

6. The upper partials are often larger in amplitude than the prime.

The second partial was occasionally a little more than double the prime; the third partial in low notes was sometimes four times as great as the prime. The fourth partial was in one case eight times as large as the prime and the fifth partial in our single example on F was one and a half times the prime.

We defer drawing any conclusions from these results until we have described the analogous phenomena observed for the vowel sound *ū*.

FLEEMING JENKIN
J. A. EWING

NOTES

PROF. F. V. HAYDEN has recently been elected Foreign Member of the Royal Academy of Sciences, Rome. This is one of the oldest scientific societies in the world, and the number of foreign members in the department of the natural sciences is only thirty-seven. The University of Rochester (U.S.) at its annual commencement on the 3rd instant, conferred on Dr. Hayden the honorary degree of Doctor of Laws. In his letter communicating its action, the president, Rev. Dr. M. B. Anderson, says:—"The Trustees and Faculty of the University desired to recognise by this action your great services to science through your personal attainments, as well as the almost unparalleled energy and success which have characterised your explorations in regions hitherto unknown to the geologist as such. They did not hope to add in the slightest degree to your well-earned reputation, but they desired to express their appreciation of the honour you have done our country and the state and city of your early residence, by those great labours which have linked your name with geological science for all coming time. The friendship of many years has made my official connection with this public act a source of the most sincere pleasure."

THE Netherlands Zoological Society held its annual summer meeting at Harlingen on July 14 last. The chairman of the Committee for the Zoological Station, Dr. Hubrecht, gave a short statement showing how the prospects of the young institution had considerably improved during the past year, how an annual income of about 150*l*. had been obtained, which had permitted an extension of the wooden building, described and figured in NATURE, as well as the application of a new heated air motor (system Rennes, Utrecht) for oxygenising the sea-water in the aquaria by a constant stream of atmospheric air. The transportable Zoological Station has been erected during the summer months of 1878, on the Island of Terschelling, between the Zuyder and North Seas, and several members of the Society are there now, for the greater part occupied in the study of the invertebrate fauna of the Dutch coast. These investigations are being considerably facilitated by the great liberality of the Marine Minister, who has put a vessel with a mate and three sailors at the entire disposal of the Committee for the next six or eight weeks. As has hitherto been done, it is expected that at the end of the season a circumstantial report will be issued by the Committee, in which the results of this year's campaigning will be duly recorded.

THE death is announced of Dr. Thomas Oldham, who was, from its origination in 1850 till 1876, at the head of the Geological Survey of India. It was under his direction that the official geological survey was commenced, first under the Hon. East India Company and afterwards as part of the Government public service; and until his retirement, from ill-health, he had the control of the issue of the official geological maps, as, portion by portion, the work was completed, and the issue of the memoirs explanatory of the maps. In 1861, eleven years after the survey was commenced, he originated the publication of the folio-sized "Palæontologia Indica," which consisted of plates, with descriptive letter-press, illustrating the fossils of the country, and the work has progressed steadily in fasciculi as an official publication printed by command of the Governor-General of India. Dr. Oldham was born in Dublin in May, 1816, and entered at Trinity College, Dublin, at the age of six teen. After taking his B.A., he studied in 1837-38 at the engineering school of Edinburgh, and attended Jameson's lectures on geology and mineralogy. Returning to Ireland in 1839, he became chief geological assistant to Major-General Portlock, then at the head of the survey of Ireland, and he helped in the preparation of the well-known report on Londonderry, Tyrone, &c., published in 1843. After being for a while curator and assistant-secretary of the Geological Society of Dublin, he held for a year the professorship of engineering, and in 1845 succeeded the late Prof. John Phillips as Professor of Geology. He was then appointed local director of the geological survey of Ireland, and the Geological Society of Dublin elected him its president. After the various experiences thus gained, in 1850 he was appointed to organise the geological survey of India. There were many unexpected difficulties to

contend with, but during the sixteen years of his office these were more or less overcome. Besides being elected a Fellow of the Royal Society in 1848, he received the Royal medal of the Society in 1875. The Emperor of Austria conferred on him a medal in recognition of his work. The papers he wrote, apart from his official work, were not numerous. He died at Rugby July 17.

IT has been arranged that Prof. McKendrick, as President of the Physiological Section at the meeting of the British Medical Association in Bath, will give an address on the recent progress of acoustics, more especially as regards the mechanism of the ear.

AT a meeting recently held at Netley of the subscribers to the Parkes Memorial Fund, it was resolved—1. That a prize of one hundred pounds in money, and a large gold medal bearing the portrait of the late Dr. Parkes, be given triennially for the best essay on a subject connected with hygiene, to be declared at the commencement of each triennial period, the prize to be open to the medical officers of the army, navy, and Indian services of executive rank on full pay (with the exception of the officers of the Army Medical School during their term of office). 2. That the subject for the first competition for the above-named prize be as follows :—"On the Effects of Hygienic Measures in arresting the Spread of Cholera." 3. That the essays be sent in to the Committee of the Parkes Memorial Fund, care of the Director-General, Army Medical Department, 6, Whitehall Yard, London, S.W., on or before December 31, 1880. Each essay to have a motto, and to be accompanied with a sealed envelope bearing the same motto, and containing the name of the competitor. 4. That a bronze medal (also bearing the portrait of the late Dr. Parkes) be given at the close of each session of the Army Medical School to the best answerer at an examination in hygiene.

AT p. 104 of this volume we called attention to an additional exception to one of Fermat's remarkable statements regarding the forms of primes. The discoverer, M. Pervouchine, has lately succeeded in showing that

$$2^{2^{23}} + 1$$

(a number containing many more than *two millions and a half* of places of figures) is divisible by the prime number

$$167,772,161$$
or
$$5 \cdot 2^{25} + 1.$$

This result has been verified by Zolotareff of the St. Petersburg Academy of Sciences. We are not told what method he employed, but it is obviously reduced to a question of mere labour by the use of the binary scale. And even this labour may be dispensed with by the aid of very simple machinery. It is much more difficult to see how M. Pervouchine was led to choose this divisor, though it would appear that the divisor was probably first assumed and the dividend calculated from it.

THE annual meeting of German Archæologists and Historians will take place at Marburg about the middle of September.

THE American Minister for Agriculture has recently stated that in the extensive caverns of Texas enormous masses of guano are deposited. The quantity is estimated at 20,000 tons, and the quality is said to be superior to that of fish guano. Its origin must be looked for in the immense numbers of bats which inhabit these caverns. It is also reported that in the Indian Ocean several guano islands have been discovered, so that the threatened exhaustion of guano deposits need not be feared for some time to come.

IN different parts of Costa Rica grasshoppers have appeared in alarming masses, particularly near Herodia, Alajuela, and Atenas, one of the most cultivated and fertile districts of the whole country. The coffee crop for this season has been nearly all destroyed by the plague.

AT a recent meeting of the Geneva Society of Physics and Natural History, Prof. Alph. de Candolle presented a glass jar containing fruits of the coffee plant collected before maturity in Mexico, preserved in a liquid which chemical analysis proved to be salt water. It is fifty years since the jar thus filled was hermetically sealed, under the eyes of Aug.-Pyr. de Candolle, and to-day the coffee-beans which it contains are in a thoroughly satisfactory state of preservation. The water contains a solution of chloride of sodium and very small quantities of other chlorides or salts. No gas was found in solution; the water must then have been boiled, and introduced while hot into the jar. This experiment may give valuable hints as to the substitution of salt water for alcohol (of which every one knows the inconvenience) for the preservation of organic substances.

THE Japanese Government have finally authorised the immediate commencement of a line of railway between Kiôtô and Otsu, which is expected to cost nearly a quarter of a million sterling, and will probably be completed in three years. The construction of this line will have a beneficial effect upon that part of the empire, as it will afford a much needed outlet for the valuable products raised at Tsuruga, and in the rich districts in the neighbourhood of Lake Biwa.

THE Government engineering works at Shindin are a conspicuous proof of the enterprise of the Japanese, and it is satisfactory to learn from the Japan papers that the undertaking is in a highly prosperous condition. It was formed by combining the Kaga Foundry, originally started by the Daimio of Kaga in 1869, with the Vulcan Iron Works, which were bought by the government in 1872. The foreign staff at present consists of only four persons, and the works give employment to nearly a thousand skilled mechanics, exclusive of ordinary labourers. In addition to several works which have been recently executed, there are said to be sufficient orders on hand to occupy the staff for the next three years. The evidence which this establishment exhibits of the rapid development of internal trade is very satisfactory to all who watch with interest the progress of Japan.

"NOMENCLATOR STRATIGRAPHICUS: a Hand-book of the Nomenclature of the Sedimentary Rocks," by G. A. Lebour, F.G.S., is the title of a work which has been in hand for several years, consisting of a list—as complete as may be—of the subdivisions of the geological scale now or at any time in use in this country or abroad. The names are arranged in alphabetical order as the easiest for reference. The date of publication, the meaning when it seemed necessary, and the equivalence, are also given. The volume will be of at least 250 pp., and will be published as soon as the number of subscribers has reached 200. Information may be obtained from Mr. G. A. Lebour, 2, Woodhouse Terrace, Gateshead-on-Tyne.

THERE are very few botanical gardens, colonial or foreign, that can boast of such a carefully-prepared or extensive catalogue as that which Dr. Schomburgk has pronouced of the plants under cultivation in the Government Botanic Garden, Adelaide, South Australia, now before us. It comprises 285 pages; and not alone on the score of bulk, but also with regard to its contents, it is something more than a mere catalogue. The plants are arranged under their natural orders, the scientific and common names and native countries being given also. We are told whether the plant is a tree or shrub, a climber, a trailing, or a creeping plant, annual, biennial, or perennial, evergreen or deciduous, out-door or stove-plant. Besides all this are too good indices, one of English and the other of Latin names. From the preface a very good idea may be had of the climate and meteor-

ology of Adelaide, as well as of the behaviour of introduced plants from various parts of the world. The sudden changes of temperature during the Australian summer months of December, January, and February, are often very injurious to vegetation. The lengthened period of eight or ten weeks without a drop of rain, which is not uncommon, has a serious effect upon both indigenous and acclimatised plants. In the months of March, April, and May, when our own deciduous trees are putting on their fresh green foliage, the same identical European plants which have established themselves in their Australian home are assuming their autumnal tints and dropping. Alpine and tropical plants suffer in South Australia not only from the dry atmosphere, but—the tropical ones especially—from the cold of the winter months. On the other hand, the extreme heat in the month of January, coupled with the hot north wind, literally bakes the fruits upon the trees. At three o'clock in the afternoon of the 10th of January last, it is stated that the thermometer in the Botanic Garden registered 116° in the shade and 166° in the sun. The catalogue is illustrated by seventeen full-page views in the garden, engraved from photographs.

WE have before us quite a pile of *Reports* and *Proceedings* of provincial societies, all of which, we may say, appear to be in a prosperous and healthy condition. We can do little more than give the names of the societies which have issued these reports. As usual, the *Natural History Transactions* of Northumberland, Durham, and Newcastle-on-Tyne contain some papers of great importance. A paper on Eggs, by Dr. Embleton, and one on Roman remains at South Shields, by the Rev. Dr. Hooppell, deserve special mention; there are also some interesting Bewick letters. The preface to the *Report* of the Rugby School Society is rather desponding, but the contents are really creditable to the contributors, and we are glad to see the attendance is generally very good; in the Report on the Temple Observatory, a description and plan of the new buildings is given. The eighth Report of the Wellington College Society shows it to be in a state of vigorous activity, all the departments adding largely to their collections; an ethnological department has been set on foot. Besides the above we have received the *Proceedings* of the Belfast Natural History and Philosophical Society; the *Report and Proceedings* of the Manchester Field Naturalists and Archæologists; *Proceedings* of the Birmingham Philosophical Society; *Eighth Annual Report* of the Leeds Naturalists' Club; *Annual Report and Transactions* of the Plymouth Institute and Devon and Cornwall Natural History Society; *Proceedings* of the Liverpool Naturalists' Field Club; *Seventh Report* of the Croydon Microscopical Club; *Report* of the Northampton Natural History Society and Field Club; and the *Eighth Annual Report* on the Devon and Exeter Albert Memorial Museum, &c. Several of these publications contain really important papers which deserve a wider circulation than they are likely to receive in their present form. In this connection we may mention an interesting tractate published at the *Advertiser* office, Wilmston, containing an account of some Lancashire Artisan Naturalists, by Mr. A. A. Reade. From abroad we have received the *Papers and Proceedings* of the Royal Society of Tasmania; *Proceedings* of the Linnean Society of New South Wales; *Report* of the Auckland Institute; *Report* of the Dunedin Naturalists' Field Club, and the *Bulletin* of the Essex (U.S.) Institute.

THE temperature of flames has been investigated by Signor F. Rosetti (*Istituto Veneto*, ser. v. vol. iv.) in a very thorough manner by means of his ingenious calorimeter. The maximum temperature of a Bunsen flame is found to be 1,360° C., and results from a combustion of 1 volume of gas and $2\frac{1}{4}$ volumes of air. The admission of a greater or less quantity of air reduces the temperature. Changes in pressure have but slight influence on the temperature. The flame given by gas diluted with the same volume of nitrogen shows a temperature of 1,180°, and diluted with 3 volumes of nitrogen, 1,040°. The same degrees of dilution with carbonic acid show respectively 1,100° and 780°. Among other temperatures noted were the following:—

	°
Locatelli lamp	920
Stearine candle	940
Petroleum lamp with chimney	1,030
The same without chimney—	
Illuminating part	920
Sooty envelope	780
Alcohol lamp (alcohol 0·912)	1,170
Ditto (alcohol 0·822)	1,180

The slight difference in heating power resulting from widely-varying percentages of water in the alcohol is worthy of remark.

THE medical students of Paris have not forgotten that Rousseau was a botanist as well as a philosopher, and sent a delegation on July 2 to Ermenonville to celebrate the 100th anniversary of his death. Three addresses were delivered in the name of the medical body—one by Dr. Bergeron, the toxicologist, the second by M. de Lannessau, and the third by M. Baillon, himself a botanist and a professor of the School of Medicine. The speakers referred in eloquent terms to the love of Rousseau for nature, his observational genius, and his works on botany. The students had prepared a splendid crown made of *pervenches* (periwinkle, *Vinca*) the flower which Rousseau loved best, and which had been collected by them in the very forest where the philosopher spent his last years. As no boat was to be had to reach the island where the author of the "Nouvelle Héloïse" is buried, one of the students threw himself into the water and swam with the testimonial to the spot sacred to the memory of the impulsive Frenchman.

H. J. RINK has recently laid before the Dutch Academy of Sciences an elaborate paper on the alterations caused by changes of temperature in the resistance offered by mercury to the passage of the galvanic current. The coefficients found hitherto range between 0·00086 and 0·00104. The author has made experiments with seven tubes of mercury, each a metre in length, and after making all corrections for expansion of glass, &c., obtained the number 0·000989 as the coefficient for the change in the resistance corresponding to an alteration of a degree Celsius. He finds, furthermore, that the resistance increases in a more rapid ratio than the temperature.

THE great Giffard captive balloon is in the hands of a Commission appointed by the Prefect of the Seine, and composed of M. Troost, Professor of Physics at the Sorbonne, Capt. Renard, head of the balloon service of the War Office, and a few others. The Commission was appointed on July 19, and on the 20th paid its first visit to the balloon, which is attracting public notice to an unprecedented degree. Thousands of spectators look through the railings of the Cour du Carrousel at the stupendous sphere which is ready to start for its elevated station. On the 20th the wind was very violent, and no ascent was tried. The balloon will not be opened to the public before the Commission has rendered its report. A second visit took place on the 21st, when a successful trial ascent was made. A M. Carrol has designed and made wings for directing an elongated balloon. A man will be suspended under it by a rope and will try to direct it. This kind of experiment has been tried at Paris twice—by Deghen, a Viennese clockmaker, about seventy years ago, who failed; and a year ago at la Villette gasworks, by a policeman, who obtained no result. M. de Fonvielle writes that he visited the Carrol flying machine which is yet imperfect, but may eventually work. The balloon will be inflated with hydrogen gas, and the

man engaged to work the wings is an acrobat of effective muscular power. The experiment will very likely take place at Enghien, on the lake, where the balloon will be retained by a small floating buoy.

WE have received a "Catalogue des Ouvrages d'Astronomie et de Météorologie," found in the principal libraries of Belgium, prepared at the Royal Observatory of Brussels. It extends to upwards of 630 pages, and will be found of great service to those interested in astronomy and meteorology. The publisher is Hayez, of Brussels.

IN our report last week (p. 323) of the Physical Society meeting of June 22, in Mr. W. Baily's paper, the expression A cos θ should be A cos 2θ, so that the equation to the ellipse of polarisation would be

$$1 + A \cos 2\theta + B \sin 2\theta = r^{-2}\{1 - (A^2 + B^2)\}$$

The author of the paper on Complementary Colours was Mr. John Gorham, not Graham.

THE additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus*) from India, presented by Mr. Enoch; a Rhesus Monkey (*Macacus erythræus*) from India, presented by Miss Davis; a Cape Zorilla (*Ichonyx zorilla*) from Africa, presented by Mrs. J. J. Monteiro; a Common Cuckoo (*Cuculus canorus*), European, presented by Mr. G. D. Careless; three Alligator Terrapins (*Chelydra serpentina*) from North America, presented by Mr. J. H. Thompson, C.M.Z.S.; a Chimpanzee (*Troglodytes niger*) from West Africa, a Golden-headed Marmoset (*Midas chrysomelas*) from Para, two Egyptian Flamingos (*Phœnicopterus antiquorum*) from North Africa, deposited; an Eland (*Oreas canna*) born, five Amherst Pheasants (*Thaumalea amherstiæ*), an Argus Pheasant (*Argus giganteus*) bred in the Gardens.

JOSEPH BLACK[1]

THE study of the history of a science is of great importance not only from a psychological point of view, but also as throwing light on the present position of the science. In science, as in other natural products which have *grown*, we find survivals which can only be understood when the development is known. Such historical studies may very conveniently be associated with the biographies of the great scientific leaders under whom progress has been made, and whose individual mental peculiarities have left permanent impressions. I intend on this occasion to direct your attention to the life and work of Dr. Joseph Black both because he was one of the first to give to chemistry the direction which it still preserves, and because his life is of special interest to us as Edinburgh students of chemistry.

Joseph Black was born at Bordeaux, in 1728. His father, John Black, was a native of Belfast, a member of a Scottish family settled in Ireland. His mother belonged to the family of Gordon, of Halhead, in Aberdeenshire, and was a cousin of Dr. Adam Ferguson. In 1740 he was sent home and educated at the Grammar School of Belfast. In 1746 he matriculated at the University of Glasgow, where he remained till 1750, studying in the faculties of arts and medicine. He then removed to Edinburgh, where he graduated as doctor of medicine in 1754. In 1756 he was appointed Professor of Anatomy and Lecturer on Chemistry in the University of Glasgow. He soon exchanged with a colleague the duty of teaching anatomy for that of physiology, and continued to lecture on physiology and chemistry till 1766, when he was called to Edinburgh to succeed his friend and teacher, Dr. Cullen, in the Chair of Chemistry. He died November 26, 1799. Such is a brief sketch of his quiet and uneventful life. His contemporaries Dr. Robison and Dr. Adam Ferguson, give us some account of his manner of life and study. He was minutely accurate and careful in everything he did, and this punctiliousness and his feeble health account for the small *quantity* of work of which he has left a record. As a student he is said to have kept two sets of note-books; into one he entered observations, experiments, hints of experiments, extracts from the works of others, in fact all the miscellaneous additions to his knowledge. These he afterwards transcribed into the other set, arranging them in order of subjects. "In short," to quote Dr. Robison, "he kept a journal and ledger of his studies and posted his books like a merchant." It has occurred to me that possibly this mention of Dr. Black's business-like habit may have been present to the mind of Sir Walter Scott when describing the interview of Francis Osbaldistone on his return from Bordeaux, with his father. "—but what have we here? 'Bordeaux founded, castle of the Trompette, palace of Galienus,'—well, well, that's very right, too. This is a kind of waste book, Owen, in which all the transactions of the day, emptions, orders, payments, receipts, acceptances, drafts, commissions, and advices are entered miscellaneously." "That they may be regularly transferred to the day-book and ledger," answered Owen; "I am glad Mr. Francis is so methodical."

His style as a lecturer is well described by Dr. Robison:—

"He endeavoured every year to make his courses more plain and familiar, illustrating them by a greater variety of examples in the way of experiment. No man could perform these more neatly and successfully. They were always ingeniously and judiciously contrived, clearly establishing the point in view, and never more than sufficed for this purpose. While he scorned the quackery of a showman, the simplicity, neatness, and elegance with which they were performed were truly admirable . . . his students were not only instructed, but (they knew not how) delighted; and without any effort to please, but solely by the natural emanation of a gentle and elegant mind, co-operating, indeed, with a most perspicuous exhibition of his sentiments, Dr. Black became a favourite lecturer." His private life was one of unvaried regularity and order, and was brought to a fit close by his death, which is thus described by Dr. Adam Ferguson.

"His own constitution never was robust, and every cold, or any approach to repletion, affected his breast so much as to occasion a spitting of blood. This he guarded against by restricting himself to a moderate or abstemious diet. As his infirmities increased with age, he met them with a proportionate attention and care, regulating his food and exercise by the measure of his strength; and thus preventing the access of disease from abroad, he enjoyed a health, which was feeble but uninterrupted, and a mind undisturbed in the calm and cheerful use of his faculties. A life so prolonged had the advantage of present ease, and the prospect, when the just period should arrive, of a calm dissolution. This accordingly followed on the 26th of November, 1799, and in the seventy-first year of his age, without any convulsion, shock, agitation, or stupor, to announce or retard the approach of death. Being at table with his usual fare—some bread, a few prunes, and a measured quantity of milk diluted with water, and having the cup in his hand when the last stroke of his pulse was to be given, he appeared to have set it down on his knees, which were joined together, and in this action expired, without spilling a drop, as if an experiment had been purposely made, to evince the facility with which he departed. So ended a life which had passed in the most correct application of reason and good sense to all the objects of pursuit which Providence had prescribed in his lot." . . . "He had long enjoyed the tender and affectionate regard of parents whom he loved, honoured, and revered, with the delightful

[1] Abstract of Lecture to the Edinburgh University Chemical Society, by Prof. Crum Brown, F.R.S.

consciousness of being a dutiful son; one of a family remarkable for sweetness of disposition and manners, he had lived with his brothers and sisters in terms of mutual love and attachment. He had never lost a friend but by the stroke of mortality, and he felt himself worthy of that constancy of regard. He had followed a profession altogether to his taste, and had followed it in a manner, and with a success which procured him the esteem and respect of all competent judges, and set his name among the most eminent, and he was conscious that his reputation was not unmerited; and with a success, in respect of emolument, which secured the respect even of the ignorant; which gave him the command of every rational gratification, and enabled him to add greatly to the comforts of the numerous descendants of his worthy parents—heirs not only of their name, but likewise of their unambitious moderation and amiable simplicity of character."

Such was Dr. Black as described by those who knew him intimately. We at a greater distance from him can, perhaps, more accurately estimate the character and value of his work. This may be considered under the heads of his three great discoveries. 1. The nature of the difference between the mild and the caustic alkalies; 2. The latent heat of liquids; 3. The latent heat of vapours.

As a student of medicine in this University his attention was early drawn to the chemical characters of caustic potash and caustic soda, the merits of which as remedies in cases of urinary calculus were then much discussed.

Two kinds of alkalies, the caustic and the mild, had long been distinguished. The former act in a burning, caustic, destructive way on animal and vegetable tissues, the latter do not; the latter effervesce when mixed with acids, the former do not; the former are typified by quick or in slaked lime, the latter by chalk or calcareous earth. Previous to Dr. Black's experiments the difference was thus explained:—When calcareous earth is burnt it becomes quick-lime by taking up from the fire a fiery, caustic matter; some of this is given off as heat when lime is slaked, but some of it remains and gives the causticity by which slaked lime is distinguished from calcareous earth. This causticity is transferred (because the caustic matter is transferred) from the lime to other alkalies. Thus, when slaked lime is mixed with a solution of potashes we obtain caustic potash and the lime becomes mild, is re-transformed into calcareous earth, having parted with its *causticum* to the potash. Similarly when sal ammoniac is heated with calcareous earth we obtain sal volatile; but when we act on sal ammoniac with slaked lime the *causticum* passes from the lime to the volatile alkali and caustic ammonia is produced. In all these cases the caustic matter or *causticum* originally obtained from the fire was believed to be transferred from one alkali to another. The effervescence which occurs when a "mild alkali" is treated with an acid was of course observed, but it was looked upon merely as a symptom of the violent movements caused by the mutual saturation of acid and alkali.

When slaked lime is exposed to the air it gradually returns to the condition of calcareous earth. On the hypothesis stated above, it must therefore gradually give off its *causticum* into the air. Black's first experiment seems to have been an attempt to catch the *causticum* as it escaped. We have no details of these early experiments, but from a note-book which can be shown to be of the date 1752 Dr. Robison extracts the following statement of the result:—"Nothing is given off, the cup rises considerably by absorbing air." Another memorandum occurs a little later: "When I precipitate lime by a common alkali, there is no effervescence. The air quits the alkali for the lime, but it is not lime any longer, but C.C.C. It now effervesces, which good lime will not."

A full account of his experiments and conclusions is contained in his graduation thesis (1754), and in a more extended form in 1756 in "Essays and Observations, Physical and Literary, read before a Society in Edinburgh"—the society which afterwards became the Royal Society of Edinburgh. In this classical paper he shows in the clearest manner that the mild alkalies differ from the caustic by containing in addition a large quantity of "fixed air," a particular kind of gas, which we now know as carbonic acid gas. This gas is given off, causing effervescence when the mild alkali is dissolved in an acid, and the caustic alkali does not effervesce because it does not contain fixed air. Wherever causticity is acquired this fixed air is lost, and *vice versâ*. When slaked lime is mixed with a mild alkali the lime takes the fixed air, and is converted into calcareous earth, while the mild alkali by the loss of fixed air is rendered caustic. In the same way sal ammoniac with calcareous earth gives a mild volatile alkali, the fixed air being transferred from the lime to the ammonia, but with slaked lime a caustic ammonia, because there is here no fixed air to be transferred. The origin of the causticity in the lime is shown to be due to the loss of fixed air which the heat separates from the limestone, and the loss of weight which is observed when limestone is burnt is shown to be exactly accounted for by the loss of the fixed air. Thus Black proved the "causticum" to be *minus* fixed air. Addition or subtraction of the former is really subtraction or addition of the latter, and transference of *causticum* from A to B is really a transference of fixed air from B to A.

It is impossible to look at such a sketch of this part of Black's work without being struck with the resemblance between the theory of causticity which he overthrew, the nature of the truth which he discovered, and the method by which he discovered it, on the one hand, and on the other the theory of Phlogiston, the true nature of combustion, and the method by which it was discovered by Lavoisier; indeed, Lavoisier himself, in a letter to Black, speaks of the new chemistry as "Une carrière que vous avez ouverte, et dans laquelle nous nous regardons tous comme vos disciples."

The discovery of the latent heat of liquefaction and of vaporisation, was made by Dr. Black while professor in Glasgow. I have occupied so much time with the purely chemical part of my subject that I shall only here point out: (1) That Black's determination of the latent heat of water agrees very closely with the most recent results of experiments conducted with all the refinements of modern science; (2) That he studied the fusion and solidification of bodies, such as resin and sealing wax, which pass *gradually* from the liquid to the solid state, or *vice versâ*; and (3) That it was his teaching which induced Watt to commence the series of experiments and speculations which led to the discovery of the dependence of the latent heat of steam upon the temperature, and to the invention of the condensing steam-engine.

A SCHOOL LABORATORY

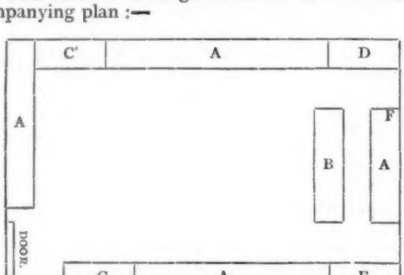
FACTS, not theories. This is the special point in the recent "Head Masters' Report" on science teaching, and, by his interesting account of it in NATURE, vol. xvii. p. 317, Mr. Tuckwell has afforded some opportunity of counting the cost to head-masters projecting a development of their science side, but apparently the Report gives no detail, and it is in this direction, perhaps, that many seek chiefly for information; they would like to know more fully what facilities may be obtained for a particular outlay.

In the hope of giving reliable information of this sort I submit the following particulars:—

The governors of Exeter School, hoping to rekindle the torch of science, lately so unhappily extinguished in the West by the Taunton College authorities, have recently

erected a chemical laboratory; it is intended for temporary use indeed, but affords facilities for school work almost rivalling those of the most costly appliances on Mr. Tuckwell's list, and at an expense not much greater than that of the cheapest; in fact, it has been arranged on a plan based upon experience of the two schools in question. I have said it is intended for temporary use; I do not mean that it is not calculated for a fair term of service; it is temporary because the present location of the school is not a permanent one.

Abutting a stone wall 10 feet high, there is built a room 30 feet by 26 feet, and about 16 feet to the ridge of the roof; it is lighted by skylights on each slope of the roof, and the remainder of the roof is boarded and felted. The building is of timber, floor of wood, and about 9 inches above the ground. The bare building thus described cost 88*l*. The interior arrangements are as shown by the accompanying plan:—



A A A A are working-benches giving accommodation for a class of eighteen or twenty at practical chemistry.

They are of $1\frac{1}{2}$ inch deal, supported on tressels 33 inches above the floor and are 25 inches broad, with an under-bench for holding apparatus, and with three shelves in front of them; these are 6 to 9 inches deep, the lowest hold reagent bottles, the next exercises for analysis, and the top shelves are devoted to lecture apparatus when out of use. They are 14, 30, 48 inches above the bench.

B, a lecture-table; its top is 12 feet long, 27 inches broad, $1\frac{1}{2}$ inch thick, beneath are arranged drawers and shelves; it stands 3 feet above the ground. There are two supplies of gas, one about the centre of the table, fitted with three taps, to which Bunsen burners are attached, another of much larger dimensions, for supplying a combustion furnace, which does double duty, for warming in very cold weather and lecture purposes at other times.

C C' are two slate sinks; C is 39 by 21 inches, and 6 inches deep, with three taps for water; C' is 32 by 21 inches, and 6 inches deep, with two taps; the tops of the sinks are about 2 inches above the level of the working-benches, and a third tap to C' serves to supply the condenser of a still.

D is a fume closet 51 inches long, 23 inches deep, and 64 inches high; it is ventilated by a zinc flue about 6 feet high, under which a jet of gas is burnt when necessary; its doors are 4 feet high and glazed, and the roof slants back from the top of this to the wall.

E is a cupboard 48 inches long, 26 inches deep, 75 inches high, with glass doors; inside are shelves arranged for holding apparatus likely to be damaged by the atmosphere of the laboratory. This and the fume-closet are made fairly substantially of deal and are painted or stained. Except the front, back, and sides of the lecture-table, which also are stained and varnished, all other wood-work is left bare.

Beneath B is another cupboard of plain deal, for chemicals, &c.; it is 33 inches high measuring from the ground.

Gas is supplied to the working benches by 17 jets from a 1-inch pipe, which is carried a few inches above the top of the bench round the room; the lecture-table, and a pendant with four burners for lighting purposes, are supplied by branches from this, and a third branch supplies the fume-closet.

There is a water-tap at F for lecture purposes, but no sink.

The cost of these fittings is as follows:—For gas and water fittings (the gas meter is a hired one), 21*l*. 14*s*. 7*d*.; for woodwork and sinks without water fittings, 51*l*. 3*s*. 3*d*. They are all fairly substantially made, as it is intended to move them to the laboratory to be built at the new school. This sum includes lecturer's desk and stool, waste boxes, &c. &c.

The apparatus and chemicals include a Ruhmkorff coil by Apps, giving $\frac{3}{4}$in. spark, combustion furnace, automatic copper-still, 8 lbs. mercury with suitable vessel for keeping it dry and pure under oil of vitriol, Becker's balance turning to $\frac{1}{16}$ grain, ozone generator, Bunsen's cells, fourteen doz. stoppered reagent bottles, about six or eight doz. bottles for holding solids and solutions for analysis, two doz. 5-pint stoppered bottles for holding stocks of solutions, blowpipe with Fletcher's bellows, a supply of Bunsen's burners, test-tubes, racks, chemicals, and all the other indispensables of a laboratory.

These cost, including carriage by rail, &c., somewhat under 47*l*., which sum will serve for our wants during the first six months' work.

The total cost amounts to 207*l*. 17*s*. 10*d*., to which we add about 10*l*., not more, for some office expenses. For this sum we have a combined laboratory and lecture-room, which is calculated to be sufficiently capacious to afford instruction in theoretical chemistry to 70 per cent. of a school of 150 or 160 boys, and in practical chemistry to about 25 per cent. of the same number; also to serve as an occasional class-room for another science subject.

There is nothing handsome about this laboratory; externally it is tarred, and in summer it will be white-washed; inside it is chiefly innocent of paint, and its walls are unplaned; but for real work there is very little wanting. W. A. SHENSTONE

A NEW DEEP-SEA THERMOMETER

THE most efficient deep-sea thermometer constructed up to the present has been the one known as Six's thermometer, with the bulb protected from pressure, as invented by Messrs. Negretti and Zambra, and described in NATURE, vol. ix. p. 387. This instrument has been extensively used by the expeditions sent out by various governments and scientific societies.

The disadvantages in the old instrument were the following:—1. The indices were, to a certain extent, unreliable, as, however carefully fitted, they were apt to slip down through their own weight, so that the observations were always more or less doubtful; 2. Its accuracy, even in its most perfect condition, did not attain to fractions of a degree, the closest readings differing at least half a degree; 3. The instrument had always to be carried in a vertical position, or it would become considerably deranged. As long as it was sufficient to obtain temperatures varying not less than a degree from one another the old instrument answered tolerably well in deep seas. Recently, however, the bottom temperatures of shallow seas and rivers have come under investigation, and for that purpose the instrument proved unsuitable.

The difference between the temperature at the surface of the sea and that at the depth of a few fathoms does not amount to a whole degree, as a rule, but only to fractions of a degree; hence the observations, to be of any value at all, must be made with an undoubtedly accurate and delicate thermometer. The investigation of the temperatures of the British seas has been urged upon the Government by naturalists and physicists interested in the question of the food supply of the people in its relation to fisheries. The questions of greatest importance were those regarding the influence of temperature upon the habits and migrations of fish, and the determination of the best seasons and temperatures for the development and capture of the various species. This investigation, commenced with the old instrument, has at present only shown that such instruments are not suffi-

ciently reliable for the purpose; a new, more accurate, and more delicate instrument was therefore a great desideratum, and it seems that Messrs. Negretti and Zambra have now solved this problem in a satisfactory manner.

The construction of the new thermometer will be readily understood by reference to Fig. 3. The bulb is cylindrical, and mercury is the thermometrical fluid. The neck of the bulb is contracted in a peculiar manner at A, and upon the shape and fineness of this contraction the success of the instrument mainly depends. Beyond A the tube is bent and a small catch reservoir is formed at B, for a purpose to be presently explained. At the end of the tube a small receptacle C is provided. When the instrument is held bulb downwards it is seen to contain sufficient mercury to fill the bulb, tube, and a part of the reservoir C, leaving sufficient space in C for the expansion of the mercury when the temperature rises. In this position no scale would be possible, as the apparent movement of the mercury would be confined to the space C. When the thermometer is held bulb upwards the mercury breaks off at A, but by its own weight flows down the tube, filling C and a portion of the tube above C, this portion being in proportion to the existing temperature. The scale accordingly is divided from C upwards. To prepare the instrument for observation it is only necessary to place it bulb downwards, the mercury of course assuming the temperature surrounding the instrument in the same way as any ordinary thermometer. When at any time or at any place it is required to read off the temperature, all that has to be done is to turn the thermometer bulb upwards, and to keep it in that position until the reading has been taken. This may be done at any time afterwards: for the quantity of mercury in the lower part of the stem which records the reading is too small to be appreciably influenced by a change of temperature, unless it be very considerable, while that in the bulb will continue to contract with greater cold and to expand with greater heat; and in the latter case some mercury will pass the contraction A and may fall down and lodge at B, but it cannot go further as long as the bulb remains upwards; and thus the quantity recording the temperature in the stem will remain unaltered. It is seen, therefore, that this new instrument is simply a recording thermometer, which accurately and delicately records the temperature at the time and place when and where it is turned over. It is not intended and cannot be used as a self-registering maximum or minimum thermometer.

Of course some contrivance must be provided for turning the thermometer bulb upwards at any depth in the water. For this purpose the instrument is fitted into a wooden frame loaded with shot, free to move from end to end of it, and with its weight so regulated as to render the whole just buoyant in sea-water.

In using the thermometer a cord is passed through the hole in the frame *nearest* the bulb, and the instrument is fastened by this cord to the sounding-line. In descending, the thermometer will be pulled down with the bulb downwards; but upon being pulled up, the instrument, owing to the resistance offered by the water, will turn over and come up bulb uppermost; the temperature of the spot where it turned over will then be indicated. The illustrations we subjoin will further elucidate this matter.

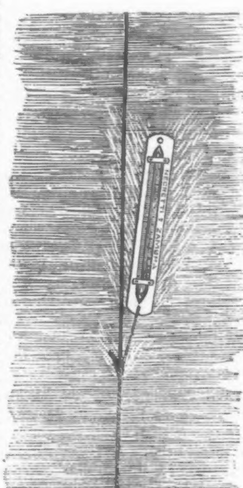


FIG. 1.—Descending.

FIG. 3.

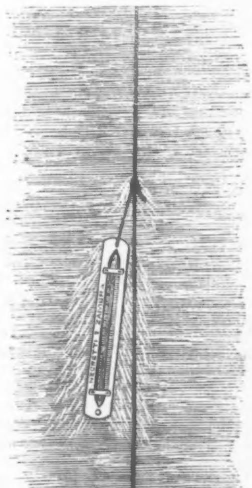


FIG. 2.—Ascending.

As regards the thermometer itself, it was necessary, in order to make it perfectly accurate, to protect it against pressure, even if intended for shallow seas, as well as for the deepest. For whether used in deep or shallow water, unless so protected, its indications would always be more or less faulty. Like an ordinary thermometer, it is devoid of air, and thus differs materially from Six's, which, containing compressed air, has a certain internal power of resistance. Hence the new instrument would be more affected by pressure than Six's, however thick the glass of the bulb. By the simple expedient of placing the entire thermometer into a glass shield or sheath, and hermetically sealing the latter, the effect of external pressure is entirely eliminated. The shield must of course be a strong one. It need not be exhausted of air. Its effect, however, will undoubtedly be to render the thermometer it protects against pressure less sensitive towards changes of temperature; in other words, it will make it sluggish. To counteract this sluggishness, some mercury is introduced into that portion of the shield which surrounds the bulb, and is confined there by means of a partition cemented in the shield round the neck of the thermometer bulb. The action of this mercury is that of a heat-conductor from the exterior of the shield to the interior of the thermometer, and the efficacy of this arrangement has been proved by experiment, the instrument thus protected being, in fact, far superior in sensitiveness to Six's thermometer.

As long as the shield withstands the pressure, the thermometer will be unaffected, and there is abundant evidence already to show that a shield of the above description will resist the pressure even at the bottom of the deepest ocean; doubtless it will be compressed a little at great depths, but the pressure will fail to have any appreciable effect upon the thermometer itself. This method of shielding is quite efficient, and thermometers thus protected need not be tested for pressure in the hydraulic press; all that is necessary is to test them very accurately for sensitiveness and for errors of graduation. The new instrument is intended to be a standard instrument and permits the reading off of at least two-tenths or even one-tenth of a degree. The test for sensitiveness determines how many seconds the instrument requires to note a change of 5° rise or fall, and the time has been found to be from five to ten seconds.

A considerable number of these instruments have already been tested at Kew Observatory with perfectly satisfactory results, which place beyond doubt their value as standard deep-sea thermometers.

Thus, provided the turning-over gear is found to answer, this

new instrument evidently possesses great advantages. It has no scale attached to it, the graduation and figures being distinctly marked on the stem itself, and the shield effectually preserves them from obliteration by sea-water. The back part of the stem is enamelled white, rendering the graduation and column of mercury extremely distinct.

When the instrument is immersed in the water the descending line may be stopped or checked any number of times, and it is of course quite immaterial in what position the instrument enters the water; the illustrations show at a glance that it will infallibly assume the position "bulb downwards" when descending rapidly, and all that is needed is that care should be taken in the pulling upwards. The first pull in this direction should be quick and sudden and be continued for some little time; at the same time the pulling upwards must be continuous, since stoppages would invalidate the readings.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

A MEETING of the members of the Yorkshire College of Science was held on Monday at Leeds. A sum of 56,000*l*. has now been promised in donations, and the endowments from the Akroyd Foundation, the Clothworkers' Company, and the bequest of the late Mr. Brown would, if capitalised, represent a further sum of about 20,000*l*. On the question of the proposed new university the committee reported that the college had held friendly communications with the authorities of Owens College, but could not at present make them the subject of a public report. Mr. Baines stated that the number of students this year was 355, as compared with 288 last year.

We have received a calendar of the Newcastle College of Physical Science, which contains full information concerning the curriculum at that institution, examination papers, scholarships, &c.

SCIENTIFIC SERIALS

Bulletin de l'Académie Royale de Belgique, No. 4, 1878.—In a further paper on the scintillation of stars, M. Montigny here deals with the changes of colour in stars of red and orange tints. From a table giving the general averages of relative frequency of the seven colours in such stars, it appears that the relative frequency of red much exceeds that of any of the other colours, whether in rainy or dry weather; that red, green, and especially orange, are in much greater proportion in dry than in rainy weather; while on the other hand, the frequency of blue and yellow is more marked under the influence of rain. Taking Pollux and Capella as samples of yellow stars, M. Montigny found in them the frequency of red and especially of yellow was much increased, while the proportion of orange was notably diminished. The proportion of blue was the same as in stars of the other type.—M. Masquelin contributes a valuable paper on the development of the inferior maxillar in man, in which he establishes the concurrence of the two modes of ossification in one bone, viz., that by the direct or metaplastic process, and that by the indirect or osteoblastic. It would thus appear that the histological process of ossification cannot serve to determine the morphological value of a bone.—A paper on oscillations of the Belgian coast, by M. Van Rysselberghe, aims at proving a sinking of the coast at Ostend, but the validity of the evidence is doubted by the reporters.—An interesting report on Daltonism in relation to railway-working is presented by M. Delbœuf.—M. Fraipont has a fourth and concluding article on the Acetinians of the Ostend coast, and Dr. Woodward records the discovery of a species of Brachyour crustacean in the coal formation near Mons (to which his attention was called by M. de Koninck).—The theory of the telephone is the subject of a note by MM. Navez.

Journal de Physique, May, 1878.—A new spectroscope here described by M. Thollon offers several advantages; it is direct vision and of perfect symmetry, and can be easily adapted to astronomical telescopes; the prisms (movable) are worked by a rigorously geometrical process, so that a ray coming along the axis of the collimator reaches the axis of the telescope only after twice traversing the whole system of prisms with the minimum of deviation; a considerable dispersive power may be had and may be widely modified in the same instrument; lastly, it affords very exact spectrometric measurements.—Some experiments in which the electro-magnetic rotation of liquids is illustrated with acidulated water containing a little lycopodium powder, the effect being projected by means of Duboscq's new apparatus, are described by M. Bertin. M. Gernez has a note on the production of different hydrates in concentrated supersaturated solutions under the influence of a mechanical action (rubbing the walls of the vessel with a rigid rod).—The metallic reflection of polarised obscure calorific rays is studied by M. Mouton.

Reale Istituto Lombardo di Scienze è Lettere, Rendiconti, vol. xi. fasc. vii.—We note the following papers in this number:—Jealous insanity, by M. Verga.—Expression of pain according to sex, age, individual constitution, and race, by M. Mantegazza.—Contributions to the study of the Italian chiroptera, by M. Regalia.—On the cranium of Volta, by M. Lombrosi.—Examination of the observations made by the committee appointed to adjudicate a prize on the theme, "Programme of a Hospital for Contagious Diseases, suited to the City of Milan," by M. Zucchi.—Study on the prevalent diseases of the vine, by MM. Garovaglio and Cattaneo.

Vol. xi., fasc. viii., ix.—In these numbers we note the following:—On dominant diseases of vines, by MM. Garovaglio and Cattaneo.—Studies on the albumen of milk and on the origin of buttermilk curd, by MM. Musso and Menozzi.—On the causes and circumstances affecting hereditary transmission in animals, by M. Lemoigne.—Observations on elephantiasis in the Arabs in the environs of the Ticinese district, by M. Sangalli.—The third molar in the human race, by M. Mantegazza.—On the distribution and termination of nerves in the tendons of man and other vertebrata, by M. Golgi.

Zeitschrift für wissenschaftliche Zoologie, vol. xxx., supplement, part 1.—On the form of the crystalline cones in arthropod eyes, especially phronima, by Oscar Schmidt.—On anomia, with remarks on the muscular system of lamellibranchs, by H. von Jhering.—The poison apparatus of ants, by A. Forel, 41 pp. two plates.—The post-embryonic formation of limbs in insects, by H. Dewitz, dealing especially with formica, 28 pp.—Contribution to the structure and development of the lungs in mammals, by Ludwig Stieda; figures from embryonic sheep, mouse, and horse.—On the ornamental colouring of Daphnidæ, by August Weismann. The author believes the colour patterns are secondary sexual characters developed by sexual selection.—On the action of the voluntary muscles in land snails, by H. Simroth.

Vol. xxxi., part 3.—Researches on the structure and development of sponges, part 4, by F. E. Schulze; 42 pp., four plates. This part deals especially with the family Aplysiadæ.—Contribution to the development of feathers, by Dr. Th. Studer, Professor at Berne; the feathers of the Penguin, Megapodius, and Dromæus, are dealt with and figured in two plates.—On the fertilisation of the egg in *Petromyzon planeri*, by Ernst Calberla, with a discussion on fertilisation generally; 50 pp., two plates.—On the formation of ova, and on the male of *Bonellia viridis*, by Franz Vejdovsky.

Journal of the Russian Chemical and Physical Societies of St. Petersburg (vol. x. No. 4) contains the following papers:—On the action of peroxide of hydrogen upon the oxygen compounds of thallium, by E. Schöne.—On the action of iodine upon certain urea and amidogen compounds, by W. Roudneff.—On nitrophthalic and oxyphthalic acids, by O. Miller.—On the admixture of zinc in different parts of the body after the intoxication with acetate of zinc, by M. Mazkewicz.—On the action of water and oxide of lead on the halogen compounds of ethylene hydrocarbons, by A. Eltekoff.—On the action of the same substances upon bromide of diamylene, by the same.—On the action of trichlorolactic acid upon urea, by D. Cech.—On the magnetic induction of the two spheres, by O. Chwolson.

SOCIETIES AND ACADEMIES

LONDON

Geological Society, June 19.—John Evans, D.C.L., F.R.S., vice-president, in the chair.—Charles Louis Buxton, Wybrandts G. Olpherts, and William Phelps Richards were elected Fellows of the Society.—The following communications were read:—On the section of Messrs. Meux and Co.'s artesian well in the Tottenham Court Road, with notices of the well at Crossness, and another at Shoreham, Kent; and on the probable range of the lower greensand and palæozoic rocks under

London, by Prof. Prestwich, F.R.S., V.P.G.S. The well-known boring at Kentish Town in 1856 showed the absence at that point of lower greensand, the gault being immediately succeeded by hard red and variegated sandstones and clays, the age of which was at first doubtful, but which were finally considered by the author to approach most nearly to the old red sandstone near Frome, and to the Devonian sandstones and marls near Mons, in Belgium. The existence of some doubt as to this identification rendered the boring lately made at Messrs. Meux's brewery particularly interesting, and the method of working adopted by the Diamond-boring Company, by bringing up sharply cut cores from known depths, gave special certainty to the results obtained. The boring passed through 652½ feet of chalk, 28 feet of upper greensand, and 160 feet of gault, at the base of which was a seam 3 or 4 feet thick, of phosphatic nodules and quartzite pebbles. Beneath this was a sandy calcareous stratum of a light ash-colour, passing into a pale or white limestone, and this into a rock of oolitic aspect. Casts and impressions of shells found in this bed showed it to be the lower greensand, whose place it occupied. The boring was carried further in the hope of reaching the loose water-bearing sands of this formation, but the rock became very argillaceous, and, when 62 feet of it had been passed through, the boring entered into mottled red, purple, and greenish shales, dipping at 35° in an unascertained direction. These beds continued through a depth of 80 feet, when, their nature being clearly ascertained, the boring was stopped. The fossils of these coloured beds, which included *Spirifera disjuncta*, *Rhynchonella cuboides*, and species of *Edmondia*, *Chonetes*, and *Orthis*, show them to be of Devonian age. Thus, the existence of palæozoic rocks at an accessible depth under London and the absence of the Jurassic series, as maintained long since by Mr. Godwin-Austen, is experimentally demonstrated. These facts are of interest in connection with the question of the possible extension of the coal-measures under the cretaceous and tertiary strata of the south-east of England. The beds found at the bottom of Messrs. Meux's boring are of the same character as the Devonian strata which everywhere accompany the coal-measures in Belgium and the north of France, being brought into juxtaposition with them by great faults and flexures. The author refers especially to a remarkable section at Auchy-au-Bois, in the western extremity of the Valenciennes coal-field, which is particularly interesting from its furnishing evidence that the Hardinghen coal-field, between Calais and Boulogne, is a prolongation of that of Valenciennes, and because the same strike and a prolongation of the same great fault observed at Auchy-au-Bois through Hardinghen would carry the southern boundary of any coal-field in the south-east of England just south of Maidstone, thence passing a little north of London. Hence it is in the district north of London that there is most probability of the discovery of the carboniferous strata. The extent of country in which shafts could be sunk to the palæozoic strata will, however, be limited by the presence of the water-bearing lower greensand, which probably reaches close to London in the south, reappears in Buckinghamshire and Bedfordshire, thirty or forty miles north of London, and probably extends some distance towards the city under the chalk hills of those counties and Hertfordshire. The nature of the representative of the lower greensand in the boring, and the characters of the fossils contained in it, lead the author to the conclusion that in it we have a deposit produced near the shore of the neocomian sea, here probably consisting of cliffs of Devonian (or carboniferous) rock. From these cliffs the calcareous material which here replaces the usual loose sands of the lower greensand was perhaps derived by the agency of springs; and the shore-line itself must be situated between the south end of Tottenham Court Road and the Kentish Town boring. The sandy beds of the lower greensand will probably be found to set in at no great distance to the southward, presenting the conditions necessary for storing and transmitting underground waters. A test boring made by Mr. H. Bingham Mildmay at Shoreham Place, about five miles from Sevenoaks, and in which the lower greensand was met with at about the estimated depth (450 feet) and furnished a supply of water, seems to confirm these views.—Notes on the palæontology and some of the physical conditions of the Meux's-well deposits, by Charles Moore, F.G.S. The chief interest of Mr. Moore's investigations centres in the sixty-seven feet of strata intervening between the gault and Devonian. In this marly and oolitic-looking deposit he found no less than eighty-five different kinds of organisms, exhibiting a singular admixture of marine and lacustrine forms of life. Foraminifera are rare, but entomostraca and polyzoa are very abundant. Some genera are found, such as *Carpenteria*, *Saccammina*, *Thecidium*, and *Zellania*, of which the range in time is greatly extended by these investigations. The author fully confirms Mr. Etheridge's reference of the beds in question to the neocomian period, widely as they differ in physical characters from the lower greensand strata of the south-east of England. From a careful study of the nature and condition of preservation of the minute organisms, he concludes that the deposits which contain them were formed at first in shallow lacustrine hollows on the surface of the Devonian rocks now lying buried at a depth of 1,000 feet below London, and that these lakes were invaded by the waters of the neocomian sea, with the deposits of which their sediments were in part mingled, and under which they were finally buried.—The chair was then taken by Prof. Prestwich, M.A., F.R.S., vice-president.—On *Pelanechinus*, a new genus of sea-urchin from the coral rag, by W. Keeping, F.G.S., Professor of Geology in the University College of Wales.—Remarks on *Saurocephalus*, and on the species which have been referred to that genus, by E. Tulley Newton, F.G.S., of H.M. Geological Survey.—A microscopical study of some Huronian clay-slates, by Dr. Arthur Wichmann.—On a section through Glazebrook Moss, Lancashire, by T. Mellard Reade, F.G.S.—On the tertiary deposits on the Solimoes and Javary Rivers in Brazil, by C. B. Brown. With an appendix by R. Etheridge, F.R.S., and communicated by him.—On the physical history of the English lake-district, with notes on the possible subdivision of the Skiddaw slates, by J. Clifton Ward, Assoc. R.S.M., F.G.S.—On some well-defined life-zones in the lower part of the Silurian (Sedgw.) of the Lake-district, by J. E. Marr. Communicated by Prof. T. M'K. Hughes, F.G.S.—On the upper part of the Bala beds and base of Silurian in North Wales, by F. Ruddy. Communicated by Prof. T. M'K. Hughes, F.G.S.

Anthropological Institute, June 11.—Mr. John Evans, D.C.L., F.R.S., president, in the chair.—Dr. J. Beddoe, F.R.S., read a paper on the Bulgarians, referring more especially to the skull-form, on which he quoted Virchow and Kopernicki, but gave also some observations of his own. Not one of sixteen skulls hitherto examined, and procured in different districts of Bulgaria, presented anything like the true Slavonic type, though a few slightly approximated towards it. Almost all were of a cylindrical form, with a considerable parieto-occipital development, and a low, narrow, sloping frontal region; there was an absence of frontal parietal bosses; the skulls inclined to be long, except those few which indicated an admixture of the Slavic type. The majority nowise reminded one of either the Slavic or Turkic form, nor were they much like Esthonian skulls, but they were probably rather Ugrian than anything else. In some of them the great degree of prognathism, the deep nasal notch and horizontal nasal bones reminded Virchow of the Australian type. If the *physique* of the Bulgarians was a difficult and obscure subject, their *morale* presented its own difficulties. They differed from the Serbs in some points favourably; in more, perhaps, unfavourably, though some of their worst faults were doubtless what naturally arose in a subject race. The heroic type which appeared among the Serbs, whether they were Mussulman, Rayah, or free Christian, and culminated in the splendid barbarians of the Montenegro, was absent here. There was no chivalry, but mere ferocity, in their ballads. Their religion was little above Fetishism, and had little connection with morality. Manliness, generosity, truthfulness, and respect for women were scarcely to be expected of such a people; but ambition was there, and industry and acquisitiveness to a degree not found among the Serbs; and the desire of knowledge was there, and the capacity to learn, and, but for the interference of Russia, and the vast amount of moral and physical evil brought about thereby, they might gradually, under a government which, though faulty, was improving, have developed into better things.—Miss A. W. Buckland read a paper on the stimulants of the ancients and of modern savages. The paper commenced by stating that all races have acquired the use of stimulants in some form, but that the stimulants of the lower races, such as the Australian, consists merely of leaves and roots, chewed for their strengthening and invigorating properties, this being only a slight advance upon the instinct which prompts the inferior animals to seek out certain plants for medicinal purposes. The first step towards the manufacture of stimulating drinks is seen in the kava of the South Seas. This art of producing fermentation by the masti-

cating process can be traced in a line across the Pacific from Formosa, where rice is the ingredient thus employed, to Peru and Bolivia, where maize is used for the same purpose, the manufacturers being always women. The next advance is that acquired by agricultural races, who make a kind of beer from the chief cereal grown by them. This liquor probably reached our shores from Egypt, where it was very early known, through the lake dwellers, and still forms the principal drink of all African races. Pastoral tribes, meanwhile, use the milk of their flocks and herds and the honey of wild bees in the manufacture of their fermented drinks: hence the celebrated *koumiss* and *mead* of Scythic nations, the same liquors reappearing among the Kaffirs in South Africa, the vessels used in both countries being the skins of animals, which were also used for storing wines in the East. Later, in Greece and Rome mead was a favourite beverage of the Scandinavians and Anglo-Saxons, and there seems to be a shadow of the Scythic *koumiss* in the Devonshire liquor known as white or grout ale, whilst both liquors may be traced more distinctly in the famous *amrita* and *soma-wine* of the Vedas. Various plants and fruits have been used in all civilised and semi-civilised countries from very ancient times in the manufacture of wines, but grape juices had formerly a circumscribed range, having been confined to Western Asia, Egypt, Greece, and Rome, but forbidden in China and the vines extirpated. The religious ceremonies and prohibitions attached to these various beverages were briefly noticed, as also the deification of plants on account of their medicinal properties and the form and material of drinking vessels, whilst alcohol, the latest and most pernicious development of the art of manufacturing stimulants was only mentioned as not having been included among the beverages of the ancients nor known to savages until introduced by Europeans.—The Director then read a paper by Mr. John Sanderson on polygamous marriage in South Africa.

PARIS

Academy of Sciences, July 16.—M. Fizeau in the chair.—The following among other papers were read:—Remarks on the influence of atmospheric electricity of weak tension on vegetation, by M. Berthelot. *A propos* of M. Grandeau's experiments, M. Berthelot recalls his own, proving fixation of free nitrogen on organic matters under weak electrical action, &c., such action (in nature), being probably more efficacious than that of thunderstorms, owing to its duration and extent.—On a *brochure* of M. Hirn relating to whirlwinds, by M. Faye. M. Hirn distinguishes two kinds of descending whirling movements, represented by cyclones and by trombes. The former (he considers) are propagated naturally downwards by simple lateral communication of a gyratory motion, originating in the upper regions. They enlarge and diminish in rapidity (owing to friction). For the other class, which become more and more restrained in their transverse dimensions (and take the figure of an upright, not an inverted, funnel), he calls in a small force in the form of electricity of the clouds, and the attraction between them and the ground through an imperfectly conducting medium. M. Faye doubts this view, and supposes mechanical identity of the two phenomena.—Processes and apparatus for study of the velocity of propagation of excitations in different kinds of motor nerves in mammalia, by M. Chauveau. In this note he merely describes his mode of experimentation, which was on mammalia of large size, chloralised, or subjected to section of the bulb and artificial respiration. He used induced currents for the (uncovered) nerve, by the unipolar method. At each turn of an automatic distributer the current is passed to a different point of the nerve. The results of experiment are stated to differ from those of Helmholtz in his experiments on the nerves of a killed frog.—General Morin referred to the loss sustained by the Section of Mechanics in the death of General Didion, author of a "Traité de Balistique," &c.—On galvanoplasty of cobalt, by M. Gaiffe. Cobalt may be advantageously substituted for iron and nickel, as a protective layer for engraved and typographic plates. M. Gaiffe uses a bath of neutral solution of the double sulphate of cobalt and ammonia; the anode a sheet of platinum or (better) a plate of cast or forged cobalt. The current is kept at about six B.A. units, and reduced to three, when the whole piece has become white. The deposition may be made nearly as rapid as that of nickel.—On the existence of lesions of the anterior roots in acute ascending paralysis, by M. Vulpian. These lesions, found in every preparation (the spinal cord being unaltered), consisted in fragmentation of the myeline into drops and droplets, hypergenesis of the protoplasm of each inter-annular segment, and multiplication of the nuclei of Schwann's sheath. The cylinder-axis had completely disappeared.—M. Ducretet presented (through M. Du Moncel) a stethoscopic microphone of great sensibility. He utilises M. Marey's delicate tambours, the vibrations of sound from the body acting on the elastic membranes.—Discovery of a comet by Mr. Lewis Swift, at Rochester, U.S. (telegram from the Smithsonian Institution).—Measurement of the calorific intensity of solar radiations, by M. Crova. This relates to observations last year. The intensity at mid-day increased from the end of January to March 15, when there was a maximum of 1·320 cal. The minimum was on June 28 (1·023 cal.); then the radiation increased, and on October 16 reached the pretty high value of 1·260 cal. As before, the weakest radiations were with S. or S.W. winds and comparatively high temperatures; the strongest with N. or N.W. winds and low temperatures; the former winds increasing, the latter diminishing the vapour in the atmosphere. The author adds some observations on this last point.—On the reform of some processes of analysis in laboratories of agricultural stations, and observatories of chemical meteorology; volumetric determination of sulphate contained in water, by M. Houzeau. A new method for the latter is described.—The septicity of putrefied blood is destroyed by a very long contact with compressed oxygen at high tension, by M. Feltz.—Identity of nature of spontaneous and traumatic erysipelas; consequences, by M. Real. A discussion took place on explosions in flour-mills, *à propos* of a recent letter of Mr. Lawrence Smith from the United States.—Structure of the stem of Sigillaria, by M. Renault.

GÖTTINGEN

Royal Society of Sciences, March 2.—The following, among other papers, were read:—Comparative anatomy of the crystalline lens, by Prof. Henle.—The bursæ of Ophiura and their homologies with the Pentremites, by Prof. Ludwig.

May 4.—The systematic position of Sclerophylax and Cortesia, by Prof. Grisebach.—Observations on the pharmacology of Salicin, by Dr. Marmé.—Relation of the left intercostal vein to the vena azygos, by Prof. Brunn.—Some Avestic words and forms, by Prof. Bezzenberger.—Coptic-Arabian inscriptions in the University library, by Prof. Wüstenfeld.

CONTENTS